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THE

ENGINEERING MAGAZINE

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INDUSTRIAL CONDITIONS AND THE MONEY MARKETS.

By Maurice L. Muhleman.

TO the close observer of events the fact that the world's money markets exercise a most potent influence upon industrial development is well known. The view held by many of our fellow-countrymen that the transactions of the exchanges, and more especially those of the stock exchanges, are merely speculative or gambling operations, and have therefore only a sinister influence, is a superficial one; for beneath the surface it will be found that actual values are there determined as accurately as the assayer discovers the quantity of precious metal in a mass of ore subjected to his processes.

The money markets, as a whole, are the places where *credits* are ascertained and exchanged; and, although the movements are not always governed by the highest motives,—rarely, if ever, by sentimental ones,—the net results will generally be found to have been based upon facts affecting values, considered from the purely economic point of view. This does not imply that the gambling element is entirely without influence, but that this influence, being of a temporary character only, is by no means the controlling one; and that in the long run it plays but an unimportant part in the determinations of the great financiers and the trusted bankers who are placed—by investors—in the position of arbiters of the destinies of industrial enterprises. Stock-exchange prices themselves do not affect the value or the prospects of an undertaking: they merely constitute the monetary index of the conditions which *do* affect such prospects.

The men of the money markets, as dealers in credits, are called upon to provide and do provide—or obtain—capital for the promotion of enterprises; and it is upon their judgment that the investor ordinarily depends. Nor is the opinion of these men (among whom must be included bankers, officers of banks and trust companies, brokers, and exchange dealers) formed arbitrarily or capriciously, any more than is the discrimination of the local grocer in extending credit to the sober, industrious mechanic rather than to the idle inebriate.

Inasmuch as no extended industrial development is possible unless the promoters are able to command the necessary capital at cheap, or certainly at reasonable, rates, the beginning of new enterprises and the continuance of such as have already been begun are dependent upon the conditions governing the money markets for the time being. When capital is scarce and interest rates abnormally high, loans or investments cannot be obtained at profitable rates even for the most promising undertakings. Industries requiring financial support will consequently languish, and the spirit of progress meets with little encouragement. The same results follow upon conditions almost exactly the reverse,—an abundance of money and abnormally low rates of interest,—when general credit has been impaired by circumstances arousing suspicion. These conditions have existed since 1890.

During the years immediately preceding 1890 we witnessed an unprecedented "opening up" of new sections of the world and the inception of public works upon a large scale. Under the apparent lead of the great London banking house of Baring Brothers & Co., capital, not only from Great Britain, but from all of the loaning nations of Europe, had been freely advanced to promote some of the most gigantic enterprises of modern times. The usual number of "wild cat" undertakings also received assistance, and assumed sufficiently great proportions to cause the force of the reaction which followed in 1890 to shake international credit to its foundations.

The credit institutions of Europe began almost immediately to draw in their monetary forces, and capitalists, fearful of further losses, preferred to submit to serious reductions in their incomes and even to allow funds to lie idle. The cash holdings of the issue banks of Europe steadily increased, until at the end of 1895 the sums so held were greater by nearly $650,000,000 than at the end of 1890, without a corresponding increase in their loans or their note issues; in a number of institutions the deposits practically doubled during the period. The decrease in the amount of new capital placed in London was over $2,000,000,000 for the years 1891-95 compared with 1886-90, and the accumulations of idle capital reduced the interest rates to less than one per cent. in 1895. We have, therefore, conclusive evidence that the investing public (the owners of capital) was and still is unwilling to advance money to any considerable extent compared with former years. No obligations which were in the slightest degree under the cloud of distrust could be disposed of at anything like reasonable rates. On the other hand, a few securities of the very highest character appreciated in value to a remarkable degree; thus the British Consols, bearing interest at the rate of only 2¾ per cent., and which in 1890 sold as low as 97, rose to 107 at the close of 1895, and have since been quoted at 110. The extent to which the absence of ordinary credit in the money markets affected business and the world's industrial development it is impossible to estimate, even approximately.

When it is borne in mind that the five years under consideration (1891-1895) cover a period during which the world produced more gold than in any preceding period of five years in its history, thus affording a greater additional supply of the material upon which capital is based than was ever before available for industrial uses; and when we recall that, contemporaneously with the conditions already referred to (and directly traceable to them), an enormous shrinkage of values and incomes took place, while the burden of taxation was absolutely increased rather than diminished,—the tremendous loss to the world and to civilization through the financial earthquake of 1890 may be appreciated to a perceptible degree, although never measured. The suspicion generated by the losses of that year gave rise to a distrust which time alone can allay; the absence of normal credit was all but universal. The men of the money markets were powerless, and their losses were also great, since the profits of the overwhelming majority of them depend chiefly upon an active conversion and employment of capital at reasonable rates, with abundant credit for all legitimate undertakings.

In the United States the conditions during the two years preceding 1890 were such that the effect of the upheaval in Europe and elsewhere was not felt so severely at once. Under the existing political system our industrial organization is to a considerable extent independent of, and unaffected by, the fluctuations of prosperity in other countries; but even these protected industries could not for any length of time remain uninfluenced by the continued stagnation in the monetary world abroad.

To a country whose exports consist chiefly of the products of the soil and the mines, and whose growth therefore depends to a great degree upon the settlement of new sections and their development through the introduction of transportation facilities and improved machinery of all kinds, surplus and unemployed capital is absolutely indispensable. But these very conditions render it impossible for our own people to provide cheap capital in ample volume, and hence we have for many years been depending upon foreign countries, principally Great Britain, France, and Germany, for a very large part of the necessary funds to continue our industrial development.

When, therefore, soon after 1890, foreign funds were not so readily procured, our development was checked. This became manifest first in the decrease in railway construction; and necessarily the industries dependent on the demand for material and motive power which an active extension of transportation facilities creates were soon affected. This in turn reacted upon other trades, until finally the wave must have reached the farthest hamlet of the country. Consumption of material and commodities became restricted, and for a time it appeared as if the country had been overproducing enormously.

The effect upon general business can not be illustrated better than by comparing the volume of transactions of all the clearing-houses of the United States for the three years last past, with that for the three preceding ones; side by side are given the amounts of *new* securities (both bonds and stocks) listed in New York.

(In millions of dollars.)

Year.	Clearings.	New Securities.	Year.	Clearings.	New Securities.
1890	60.623	275	1893	54.323	244
1891	56.718	288	1894	45.686	*121
1892	62.109	360	1895	53.348	*170
Total,	179.460	923	Total,	153,357	535
Average,	59.820	308	Average,	51.119	178

The average annual decrease of business, as thus shown, is over $8,700,000,000, while the average annual decrease in the bonds and shares placed on sale, representing new enterprises, was $130,000,000. It will be observed that, while the year 1891 showed some falling off in business, the actual settled shrinkage did not take place until 1893; in fact, in many respects the year 1892 may be regarded as the one of the greatest expansion, showing conclusively that the country had to that date apparently withstood the effects of the shock under which the rest of the world had been struggling along. Immigration to the United States from Europe was greater in 1892 than ever before, and did not diminish until after the spring of 1893.

Before proceeding with the consideration of our home affairs during this period, it will prove useful to examine our international relations. An element peculiar to this country existed to add to the general distrust manifested in the money centers of Europe. This was in great measure founded upon a failure on the part of foreigners to fully comprehend our heterogeneous currency system, which, it may be

* After deducting for United States loans, 1894, $100,000,000, and 1895, $63,000,000.

said, the mass of our own people take more upon faith than by reason of a clear understanding. We have an unbounded faith in the absolute financial integrity of the United States, and anything in the form of money bearing the federal stamp is accepted freely by us. But to the foreigner—especially the money-loaning foreigner—this sentiment counts but little. Being a question of credit, pure and simple, failure to understand breeds distrust. Accordingly, not only did we fail to obtain further advances of money to promote our enterprises, but much of the capital already invested here was from time to time called back. The total excess of exports over imports of merchandise and silver for 1881-1895 was $627,000,000 ; and the excess of gold exports amounted to $251,000,000. In return we received a mass of our obligations, for which a market had to be found here, necessarily causing a steady decline in the prices of such bonds and shares as had enjoyed a foreign lodgment.

Apparently we were strong enough financially to endure the strain thus put upon us as a nation up to the end of 1892. But eventually it became too great, and general disaster was only partially averted by the skilful handling of all of our available forces. Money was hoarded in 1893, and a severe stringency followed.

The effect of this apparently enormous withdrawal of capital from ordinary use inevitably operated disastrously upon the entire industrial organization, and, reacting, restricted the demand for capital, since all gainful occupations are interdependent. The cessation of development threw certain kinds of labor out of employment, reducing their capacity for consumption, including under that term all that enters into the maintenance of life. This in turn served to diminish the need for other labor, and accordingly a series of changes took place which it is impossible to illustrate fully by means of existing statistics. We are able, however, to indicate a few points in the table below.

SOME INDUSTRIAL STATISTICS, UNITED STATES, 1890 TO 1895.

YEAR.	Railways.					Pig Iron product thou. tons	Deposits in Savings Banks.† millions.
	Miles built.	Earnings millions.	Expenses millions.	Freight miln. tons.	Employees thousands.		
1890	5626	1098	754	691	749	9203	1525
1891	4620	1138	782	704	784	8280	1623
1892	4584	1205	846	749	821	9157	1713
1893	2789	1223	858	757	874	7124	1785
1894	2157	1080	758	675	780	6657	1748
*1895	1800	1155	803	710	810	9446	1811

* Statistics of Railways 1895 estimated. † Given for middle of year.

Railway construction, being largely aided by foreign capital, showed the effects earlier than other industries ; and the earnings of the transportation companies did not diminish until 1893,—a year later than would have been the case but for the World's Fair. The expenses of railways fell off from 1893 to 1894 fully $100,000,000, and the services of 94,000 employees were dispensed with. The difference between the railway construction of 1890 and that of 1895 represents a sum of $230,000,000, and the decrease in the product of pig iron in 1894 compared with 1890 meant an approximate loss of nearly $30,000,000 in this single branch of the industry. If the manufactures of the entire nation suffered a similar diminution, the value of the product decreased $2,600,000,000, with a loss in wages of fully $600,000,000. It is not surprising, therefore, to find that the savings of the frugal ones increased only $72,000,000 in 1892-3 and were trenched upon to the extent of $37,000,000 in 1893-4, instead of being increased by $98,000,000 as in 1890-1, or by $90,000,000 as in 1891-2. Had the ratio of increase during the latter period been maintained, the amount of these deposits in 1895 would have been $2,073,000,000, or $262,000,000 greater than was actually the case. After 1893, on the other hand, the deposits in the discount banks increased rapidly, and money was loaned upon call at rates as low as ½ per cent.

Let us now examine the effect upon the market price of shares of the series of disturbances, foreign and domestic, which we have suffered since 1890. We have seen that two important forces operated to depress these prices,—the "unloading" of securities on the part of foreign holders, and the stagnation in general business which reduced the dividend-paying capacity of the corporations whose shares are bought and sold in open market. The depression thus caused necessarily added to the already existing distrust.

A review of the course in the market of the shares of twenty representative corporations, chiefly railways, gives the following average prices for the end of each year:

1890.	1891.	1892.	1893.	1894.	1895.
60.21	71.22	66.50	50.48	50.77	51.54

These results show a decline since 1891 of more than 20 points, without strong symptoms of recovery.

A more detailed account of the fluctuations is shown in the exhibit below, giving the general course of average prices between certain dates of the same twenty active, representative shares.*

1890.	1891.	1892.	1893.	1894.	1895.
Rising	Rising	Rising	Rising	Rising	Falling
Jan. 73.35	April 69.00	March 75.68	Jan. 70.87	April 57.27	March 48.75

* From the *Wall Street Journal.*

Falling	Falling	Falling	Falling	Falling	Rising
March 70.65	July 61.50	Sept. 67.97	March 62.86	Aug. 51.45	Sept. 63.77
Rising	Rising	Rising	Rising	Rising	Falling
May 78.03	Sept. 73.21	Oct. 71.43	April 66.25	Aug. 57.60	Sept. 59.66
Falling	Falling	Falling	Falling	Falling	Rising
Nov. 59.25	Nov. 67.52	Dec. 66.50	July 43.47	Oct. 51.24	Sept. 62.50
Rising	Rising		Rising	Rising	Falling
Nov. 64.03	Dec. 71.22		Oct. 57.82	Nov. 54.78	Dec. 48.56
Falling			Falling	Falling	Rising
Dec. 58.10			Dec. 50.48	Dec. 50.77	Dec. 52.76
Rising					Falling
Dec. 60.21					Dec. 51.54

These figures show the extremes nearly 35 points apart, the highest prices having prevailed in the spring of 1890 (78.03) and of 1892 (75.68); the lowest price (43.47) was in the summer of 1893, but for a short period the declines in 1895 carried the prices below 50.

The currency problem has been so fully treated in previous numbers of this magazine that reference to it has been purposely omitted here; and although the preceding pages give the reader only an imperfect view of the effects of the revulsion from which we are now recovering, sufficient has been shown to make it clear that there can be no healthy industrial development without a sound system and a relatively stable money market; that the results of a shaking of confidence are sure to react upon all enterprises, and, by affecting labor and the consuming power of the mass of the population, touch even the business of the smallest storekeeper and the most insignificant trade-worker.

Spasmodic and short-lived disturbances are rarely far-reaching in their influences; indeed, these may be expected during the most serene periods; but they pass away without injury to the industrial organization. A continued fall and general depression of the share market, however, is an indication of an approaching economic storm as surely as the depression registered by the barometer portends meteorological disturbance. The instrument of the meteorologist is not more sensitive than the share-market, and, just as the official forecaster of fair or foul weather examines his instruments and the reports which reach him of conditions elsewhere, so the men of the money markets and investors of capital look for the cause of the eccentricity of the share-list and prepare themselves accordingly,—conserving their forces, but, withal, endeavoring to the utmost to maintain the *general credit* which is the very life-blood of the industrial organism.

And, finally, what is the teaching of all this costly and varied experience? Plainly this: that to insure conditions of stable and healthy prosperity we must so order our currency system and so manage our great industrial enterprises that both will command the entire confidence of both home and foreign investors.

RAILROAD CORPORATIONS IN PRACTICAL POLITICS.

By Cy Warman.

NO branch of business, no profession, trade, or calling,—has attracted a more intelligent lot of men than are now engaged in the management of American railroads. Railroading is fascinating work and pays well. With a salary ranging from ten to fifty thousand dollars a year; with a private car, stocked at the company's expense, to say nothing of countless other perquisites,—the president of an American railroad has in some respects a better post than the president of the United States. He lives like a prince at home, and, if he is compelled to patronize a hotel, he always goes to the best to be found. He is respected even where he is known, and, if he happens to be an orator, he is invited out, and big banquets are spread in his honor. In short, the American railroad president is a great man, and his assistants are equally great—only they have not yet been promoted.

Accepting all this as true, it is hard to reconcile the fact that these brilliant men are, in one respect, the easiest game this glorious country affords. They are the especial prey of the professional politician, and do more to make the existence of the political shell man possible than any other class of citizens. They begin by giving the politician a pass, and end, in more cases than one, by assigning him a private car. It matters little what political party the professor belongs to; politicians, like whiskey, are much the same the world over, and produce the same general effect. If, in what follows here, reference is made to any political party, it will be only to prove something, and should not count for or against the party mentioned. Not a few railroad managers are beginning to see the folly of mixing in political affairs, and are gradually letting go. It is not the public alone, upon which every railroad must depend for support, that becomes an enemy of the corporation; in many instances the very employees, who ought to be loyal, and naturally are, are found cursing the company that gives them employment, because their rights and liberties as American citizens are interfered with.

The mixing of the management of a great railroad with the politics of the section through which it passes is sure to bring embarrassment to the corporation, and equally sure to bring political ruin to the party in the mix. A few instances will confirm this statement.

Until a few years ago the Republican party presided over the destinies of Nebraska. The Union Pacific railway company and the Burlington & Missouri railroad company went into politics, and the Republican party went out. At first these rival corporations were arrayed the one against the other; but they soon found that the people were against both, and then they united to control the State legislature, to elect congressmen, and dictate to the people who should go to the United States senate from the corn country. For some years they were successful, or thought they were, but with that success there came a world of work and worry,—embarrassing situations and no end of annoyances for the railroad officials whose duty it was to "take care of" the companies' friends. Among these friends were the professional politicians and all the heelers and helpers, vote-winners and ward-workers, of every flag-station along the line of either of the great roads. It required a press to print, and a pass-clerk to sign, passes for "our friends" and the friends of our friends. All this time the people who were trying honestly to make a living by growing corn or feeding cattle were becoming anti-monopolists. The feeling against the corporations grew stronger and stronger every year. Men who were placed in power by corporations were actually afraid to befriend the companies, so intense was the feeling against them and the railroads.

At North Platte a boiler-maker was mayor, and every member of the city council was in the employ of the Union Pacific railway company, and yet the company was continually harassed by this little insignificant municipality. A puddle of water on railroad land was declared a public nuisance, and no right-of-way could be secured across a street or alley. An officer of the company visited the town, met the mayor (who came from the shop to meet him, and whose time went right on), and asked why the company could not have as fair treatment as any other property-holder.

"Now, upon your honor," said the superintendent, "isn't this right and fair? Isn't that wrong and unjust?"

"Yes," said the mayor, "what you ask is perfectly fair; but we, as employees of the company, can't afford to vote that way, for the people say we are slaves of the corporations, and we have decided to stay with the people, even if we lose our places with the road."

The superintendent assured him that none of the men would be discharged; but the company took good care that no employees were elected to office, at least by the company's aid, at the following election, and, when another mayor and a new lot of aldermen came in, the railway company had no more trouble at North Platte.

A few years ago Colorado was Republican by thirty thousand. If a man was able to secure a nomination on the Republican ticket, he was sure to be elected. Colorado politics became shady. The people were beginning to get together in little knots on street corners, and kick. The politicians grew uneasy as the people showed signs of being "on." The corporations of Denver were told that, unless a lot of money could be poured into the Republican State central committee's fund, the glorious State of Colorado would be lost. The corporations came down handsomely, and the ticket was elected. When the legislature met, there was a great deal of talk about anti-railroad legislation. Some bills were introduced, which, if they had become laws, would surely have done the railroad and other interests great injustice. The corporations had prostituted themselves before the election,—signified their willingness to be worked,—and now the chief "flim-flam" of the political "buncoes" (who was himself, no doubt, the author of the proposed anti-railroad bill) came breathlessly to the corporations, saying: "We are lost, unless we can get money at once."

"How much?"

"Ninety-two thousand dollars."

He got the money. One company put up forty thousand dollars. This money all went to deepen the hue of Denver, and, when it came to a "show-down," the gentleman who was "looking after the interest of the railroads" was unable to control a single vote. In the meantime so much had been done that it looked as though the objectionable bill would pass. The situation was so serious that the substantial business men of Denver, regardless of party, and without money or price, went into the fight and defeated the bill.

When the time for another election rolled round, and the Republican State committee went down to the Union depot, they found a new man there—the same who, a few years ago, went to North Platte to see the mayor.

"Being a Republican," the spokesman began, "I presume you are with us politically?"

"You bet!" was the brief reply.

"Ah," said the politician, with a happy smile, "we can always rely upon the Union Pacific."

"Well," said the general superintendent, "if you are speaking of the company and its employees, I can't answer. I only speak for myself."

"Of course, yes—but—but you will instruct your employees to vote the Republican ticket,—that it is for the company's interest,—will you not?"

"I will not, and, if any officer or foreman in the employ of this company dares insult the employees with such a proposition, I'll see that he has plenty of time to devote to politics in the future."

The committee retired.

It should be remembered that the story above related—the $92,000 story—was still fresh in the minds of the people. They were as weary of being ruled by the corporations as the corporations were of being ruled by the politicians, and about thirty thousand good honest Republicans voted "the way they thought." The corporations found themselves confronted by a Populist governor and a legislature that was not Republican, but it came cheap. They had paid nothing for its election, and there was no bad feeling. On the contrary, Democrats and Populists felt themselves indebted to the corporations for the first fair, square, open, and honest election Colorado had seen in many years.

When the legislature met, a committee from both houses—self-appointed, perhaps—waited upon the gentlemen whose experience I have been relating, and whose companies had contributed the ninety-two thousand dollars above referred to.

"The railroad companies," began the visitors, "have been in the habit of spending vast sums of money in the legislature, for which, as you must know, they have received no benefits. We are not here to offer ourselves to the corporations; on the contrary, we wish to assure you that no lobbyist can dictate to this legislature; but, if you are bound to spend money, give it to us, and we will guarantee you fair treatment. You have claimed in interviews that all the railroads asked was the same treatment accorded individuals or other corporations, and that you can be reasonably sure of; only we object to politicians receiving money for our votes."

"Gentlemen," said one of the railroad men, "if twenty-five cents was all that was needed to defeat or pass a bill in this legislature, I could not possibly get the money, for we have done with politics. We want no special or class legislation, and, if you pass a law detrimental to our interests and the business interests of Colorado, we will beat you in the courts."

This committee was of all parties, and one of its members crossed over to a general manager, held out his hand, and said:

"If you mean that, we're with you; if you don't mean it, there will be trouble."

The railroad men assured them that they meant it, and the legislature sat down unfettered.

Colorado had for years been burdened with a "railroad commissioner," who did the State no good and the railroads no harm, save that he annoyed the officials. This semi-Populist, anti-monopolist legislature put out his light, stopped his pay, and let him go. Governor Waite vetoed the bill which abolished the railroad commissioner, and the legislature passed it over his veto.

These are not romances, but facts.

"The best part of my life since the war has been spent between corporations and politicians, and my experience is that the moment a corporation thinks it has control of the politics of a section or a county, that moment it is hopelessly in the hands of the politicians." Such was the declaration of a fearless official, whose company has done much to corrupt the politics of the west, but which, at last, in self-defence has solved the problem.

A Denver company, owning and operating one of the most perfect and complete street-railway systems in existence, is almost hopelessly entangled in the political cobweb. It has dabbled in politics to such an extent, and has become such a power, that it must always be taken into account by those who aspire to office. Here comes the blighting influence. A candidate must be elected either with or without the aid of the corporations; but from the moment he consults them he is simply an instrument in the hands of the corporation. This company has done a great deal for the city, and ought to have the good wishes of all the people, but it has not. One-half of the population—those who happen to be of the same political faith—say nothing, while the other half heap upon the heads of this company's officials bitter curses every day. Of course, this condition of affairs argues nothing against the political party whose mask the corporation wears. Such a corporation will invariably favor the political party in power in the State in which it does business.

Not long ago a national bank of Denver, which would unquestionably be doing business to-day if its officers had not endeavored to control certain politicians who had the placing of public money, closed its doors. These cases are cited because the writer knows of them. The situation in any other part of the United States is, no doubt, as bad as that of the west.

Probably no corporation in the country has been so deep in politics or suffered more from that source than the Southern Pacific railway company. It began by electing the State legislature and ended by controlling, or trying to control, United States senators and supreme court judges. It has succeeded sufficiently to earn the undying hatred of the whole population of California. It is doubtless accused of much of which it is innocent; but, when a community has learned to hate a thing as that community hates the Southern Pacific, there is no stopping it. Visit California, and you will find the present officials of the Southern Pacific as genial and obliging as those of any other railroad; yet they are actually despised personally because of their connection with this unpopular company.

Well-informed railroad men are of the opinion that the differences between the Union Pacific and the government could be adjusted without the least bit of trouble, if the Southern Pacific could be left out of the question; but, the moment the least concession is hinted at in favor of the California company, the people are up in arms.

After having controlled the politics of the Pacific coast for years, this great corporation is tottering under the load. The people of California charge that this company has not been content with controlling the greater officials, but has made its demoralizing influence felt in the election of a justice of the peace or a county constable. It has not confined itself to the operation of the Southern Pacific road, but has engaged in other enterprises, until to-day, it is said, a stranger cannot enter San Francisco without paying tribute to this corporation going and coming. While in the city, if you hire a carriage, ride in a street car, and in many cases dine at a café or attend a theater, you are paying something to the despised corporation.

Now the people are crying for a change. They long to be free from the corporation, and the corporation is doubtless as anxious to be free from the politicians it has helped to create; for it is only a question of time when they will wear out the stoutest corporation in existence. While Stanford lived, his personal popularity with the company's employees worked as a sort of leaven to the public, but now that leaven has passed away. Where the farmers and villagers are not oppressed and overcharged, they think they are, and the result is that never a dollar's worth of business is given to the railroad company where it can possibly be avoided. It would be interesting to know how much money the Southern Pacific railway company has received in the past twenty years that could be properly reckoned as the result of excessive and unreasonable freight and passenger rates. It would be equally interesting to know what the political herd has cost the company, directly and indirectly, during the same period, and to strike a balance.

Of course, all the stories told by the advocates of State ownership of railroads and by angered citizens cannot be taken as true. Still, the fact remains that the Southern Pacific railway company is in politics, and in so deep that it seems impossible for it to get out; but it *will* get out, and it will never be able to sleep o'-nights until it *is* out.

[Of course, railroad corporations have not been blameless. It is idle to pretend that they have. All over the country, and even in the lobbies of the national legislature, there have been dickerings and deals, more or less scandalous, between the railroads and the political managers. As to new charters, land grants, bond subsidies, etc., the scandals have been greatest in the newer regions, where, twenty-five years ago, railroad building was beginning, and there was opportunity—now passed forever—to secure valuable privileges. Events like the Credit Mobilier *exposé* and intrigues of a similar character have been unfortunately too frequent; but they cannot occur again, because the conditions making them have passed away. In the west, however,—indeed everywhere,—the roads have been in constant contact with legislation,—in hope of favorable, in dread of antagonistic, measures,—and there are always questions arising as to charter amendments, privileges, restrictions, rights-of-way, and passenger and freight rates. Legislation under these heads can hardly fail to involve "practical politics," and the railroad companies, willingly or unwillingly and almost helplessly, have been entangled in the mesh.

But, when the public accuses the railroads, it commonly fails to see that, taking the whole range of railroad politics into consideration, there are two sides to the case. While no doubt the roads are often to blame for instigating dubious methods, it more frequently happens that the railroad officials have had no choice, even although aiming at entirely justifiable ends or simply seeking to protect their interests against fanatical or blackmailing persecution, except to enter into the political field. Every State party boss, every little clique of professional politicians, can at will levy tribute upon the roads; and, as to the morality of this, the roads are considered legitimate game. If open threats are not used, there is an equally effective, though tacit, intimidation, backed by the prospect of adverse legislation, from which no corporation, however strong, is ever exempt; so that the railroad managers are kept in a chronic state of anxiety as to what is next going to be done to them. And, on the other hand, when something positive is needed,—as, for example, extensions of way,—the corporations feel that they must make friends either with the stronger party or with all possibly opposing parties. So, whether for self-preservation or for the sake of concessions, the roads are equally involved. Indeed, this has gone so far that it is notorious that some companies, like industrial corporations of other kinds, have contributed (and heavily) to *both* contesting parties in a general election. Does anyone suppose that this is done willingly, or as a matter of sound economy?

The causes of the trouble lie at the doors both of the corporations and the politicians. Which are most culpable is an intricate question. It is not always easy to say whence comes the initial impulse,—whether from the roads to the politicians or from the politicians to the roads. But, on the whole and in view of the significant fact that the day of great land grants and sweeping charters has passed, and the other great fact that the corporations are now on the defensive, it may fairly be asserted that the railroads are more sinned against than sinning. The fault is largely due to the prevailing low tone of politics, or, at least, of that variety known as "practical."

Railroad managers would like to know where to seek a remedy for the existing state of things, which is unsatisfactory in every respect, not only leading to a constant drain upon their financial resources, but bringing them, often undeservedly, under public censure. As has been shown by a very few out of the endless possible illustrations, when the railroads go into politics they not merely fail in their objects, but often actually defeat themselves. Have they not tried this long enough? Would it not be better to take a determined stand on a new policy, beginning with a reformation of the pass and favor system and an impartial refusal to contribute—as corporations—to any political tax-gatherer, or to in any way, directly or indirectly, influence their employees' votes, or to interfere in the selection and election of candidates? The time has come when thinking men understand the awkward position of the railroads, and a straightforward course would secure public recognition and do much toward removing popular antagonism.—THE EDITOR.]

PUMP IRRIGATION ON THE GREAT PLAINS.

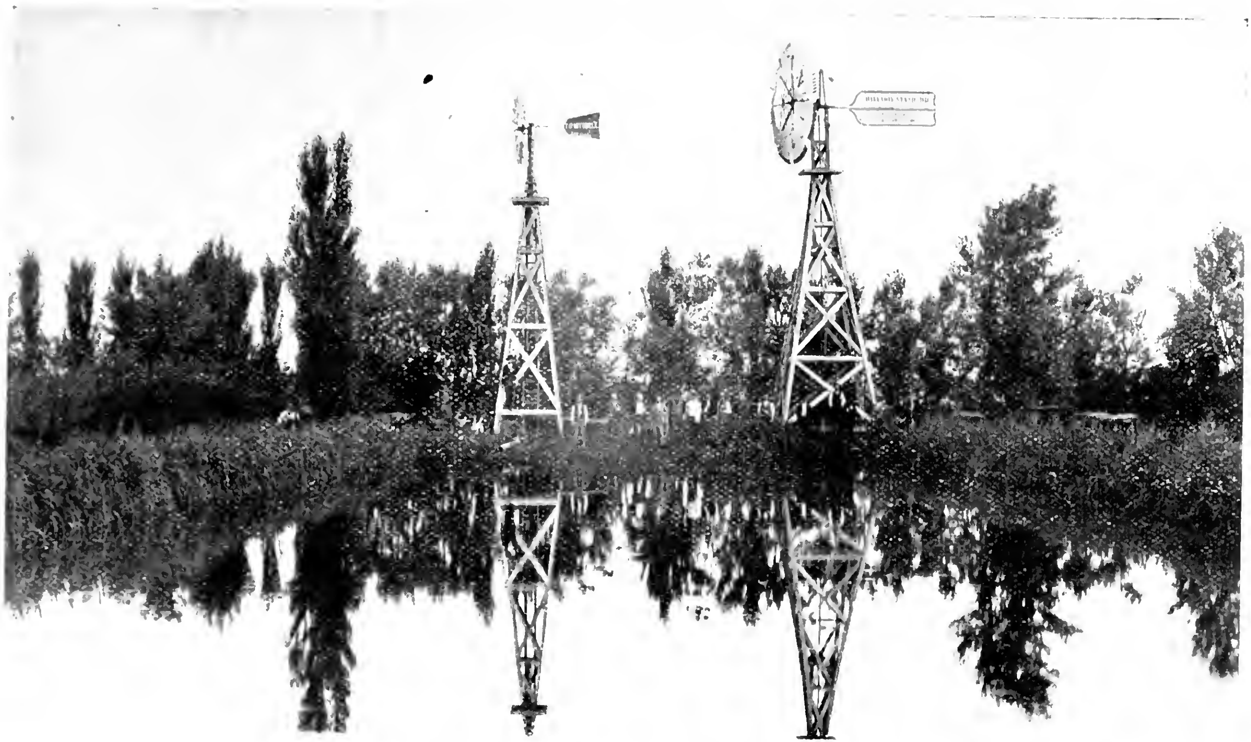
By H. V. Hinckley.

THE entry of the irrigator upon the immense plains of the West —those billion acres once described in school-books as the "Great American Desert"—is more even than an advance in the westward march of empire; it is a long step forward toward the attainment of an exact science of agriculture. Of what avail is the farmer's tripartite labor of planning, planting, and cultivating, unless it be crowned, and finished four-square and perfect, by the glad reaping and gathering into barns? And where is the non-irrigating farmer who has not learned, time and again, the burning lesson that his study and toil were of no avail when the land failed to receive the desired "water of the rain of heaven"? Where is the agriculturist who has not learned that an average annual rain-fall of forty inches will not vivify his scorching acres, if only three inches of the forty fall between June and October? What gardener or fruit-grower does not remember season upon season when he would gladly have paid five dollars an acre— yes, ten dollars or even more—to secure the water which the clouds withheld?

Nor is the disadvantage limited even to the occasional or frequent loss of a crop. It is deeper and farther-reaching still; for the tiller of the soil who depends on natural climatic conditions must perforce confine himself to raising those crops which are least injured by periods of unfavorable weather, and, as a result, we find a vast proportion of the available acreage of our country given over to wheat and corn, from which $12 to $15 per acre is a fair return to the grower. The man who can so control his environment as to grow alfalfa, and feed it, can readily raise the returns to $20 to $50 per acre: he who, through still more favorable conditions, can raise vegetables or fruit with certainty and market them with facility can increase his income to $100 or $200 per acre, or even more.

It is the certainty of the crops which is the most important element in the problem of profitable farming, and toward this nothing has contributed more in recent years than the development of pump irrigation, as yet in its infancy in the United States, though it has already reclaimed over 3,000,000 acres in British India.

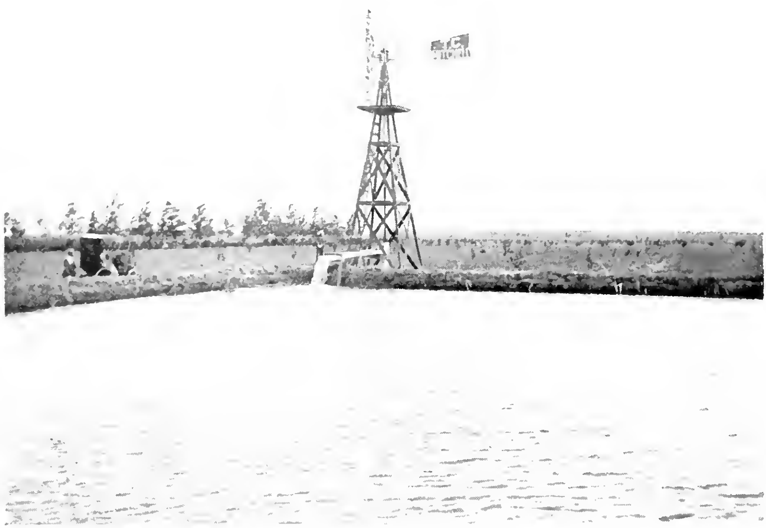
The conditions involved in securing an assured water-supply on the plains are, of course, essentially unlike those which obtain in mountainous regions. Hill countries are generally characterized by copious rainfall, and their varied elevations are likely to afford easy facilities



IRRIGATION PLANT. F. W. RICHTER, GARDEN CITY, KANSAS.

both for impounding and subsequent distribution. The simplest, and usually preferable, system requires only a dam thrown across the ravine or cañon of a stream, so as to form a mountain reservoir, and an open canal or a pipe to convey the stored waters to their intended point of distribution in the adjacent valley or plains. Where such systems have failed to pay the anticipated revenue, it has been in general through ill chosen location or bad financiering, and not through any inherent defect in the system itself.

With the approach to the plains, however, the conditions are wholly changed. Streams are often intermittent, and dry during the season when water is most needed. Natural locations for reservoirs or favorable sites for dams are infrequent: artificial storage of surface run-off



A TYPICAL PRAIRIE IRRIGATION PLANT. FILLING D. M. FROST'S RESERVOIR, GARDEN CITY, KANSAS.

is generally impracticable, and surface evaporation and loss of stored waters reach their maximum.

Furthermore, it is generally conceded that to dam a stream, say like the Platte or the Arkansas, having a practically bottomless bed of sand and alluvium, and thereby to hold back and divert the flood-waters into service canals or side-hill reservoirs, is impracticable. Numerous canals have been dug along such rivers, with the purpose of diverting a part of their flow during the flood season; but the usual result has been an annual washout of cheaply-constructed head-works and an unreliable and consequently unsatisfactory service to patrons.

HOW SMALL PUMPS MAKE A LARGE STREAM—BY RESERVOIR ACCUMULATION. E. E. FRIZELL, LARNED, KANSAS.

Circumstances must, of course, modify the verdict. Local conditions make a canal not only justifiable, but the best possible system.

Where, too, the plains break into high rolling land, as in eastern Kansas and Nebraska, storage in small reservoirs of perhaps ten to one hundred acres is often practicable and advantageous: but in the flatter valleys and the prairies another solution must be sought, which is found, not in bringing water down from above, but in pumping it up from below.

For beneath a great extent of the prairie, arid and unpromising-looking on its surface, lie vast bodies of subterranean water, filling the spaces of the underlying sands and gravels and moving through them, slowly but constantly, toward the ocean or the valleys of the

GASOLINE CENTRIFUGAL PLANT OF KIPP AND KIMBALL. ONE OF EIGHT ON THE BLUE RIVER, BELOW HASTINGS, NEBRASKA. ENGINE AND BELTING HOUSED. WOODEN SERVICE FLUME TO GARDEN. BLOWING OFF, IN PHOTOGRAPH, FOR EFFECT.

great rivers which flow into it. The underflow in this great gravel basin is maintained by rainfall sinking through the soils above during the months of heaviest precipitation, and perhaps still more by the lateral downward flow, through deep strata, of storm and snow waters from the surrounding, though often distant, hills.

In the utilization of these underground waters lie the largest possibilities for the reclamation and development of our arid lands; and beyond the possibility of fertility there is another and in some aspects a higher boon conferred by pumping irrigation,—that is, the maintenance of individualism and liberty as contrasted with dependence upon a "soulless corporation" which, in exchange for the water furnished,

L. L. DOTY'S CABBAGE PATCH, GARDEN CITY, KANSAS. RESERVOIR AND MILL IN BACKGROUND.

"COMING THROUGH THE RYE." GARDEN CITY, KANSAS.

puts a bond upon the tenants' freedom; the preservation of the "little farm well tilled," with all that it implies of sturdy manhood and self-reliance, in contradistinction to the commercialized and to that extent dehumanized "bonanza" farm enterprises of the west.

It is, however, greatly to be regretted that so many who have undertaken the task have failed to realize that they were confronted by a problem in engineering, rather than in finance or politics. They have undertaken to interpret natural law without proper professional advice, and in natural consequence are fined for contempt in nature's court.

And yet so abundant is her generosity that the percentage of failures

VEGETABLE FARM. D. M. FROST, GARDEN CITY, KANSAS. RESERVOIR, "MOGUL," AND TOWER MILL IN BACKGROUND.

PART OF 500-ACRE ORCHARD. TAKEN FROM TOP OF HOUSE. RESERVOIR AND PUMP-HOUSE IN BACKGROUND. G. M. MUNGER, EUREKA, KANS.

is extremely small. The Kansas State Board of Irrigation reports the number of pumping plants of all kind erected during the past five years as being 18 in 1891, 33 in 1892, 55 in 1893, 224 in 1894, and 1241 in 1895; and of these only six pronounce irrigation by pumping a failure.

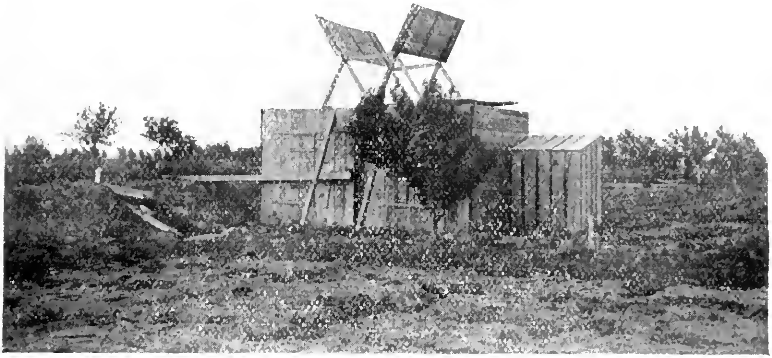
Considering the opportunity for mistake or misguidance, such a record is little short of marvellous. It is so easy to put a 2000-gallon-per-minute pump on a 500-gallon-per-minute well, or to assume that with an "average" rainfall of twenty inches, but little additional water will be needed, forgetting that it is not the *average*, but the *minimum* of five inches in the year and only two inches in the first six months against which provision must be made.

It is so easy to go astray in calculations based on manufacturers' figures of indicated and actual horse power, of friction and water lift; or to base windmill computations on catalogue figures of fifteen miles an hour when the average of the locality is only eleven; or to forget the "law of squares," and the fact that the wind is lightest in the season when the need may be greatest.

And yet, in spite of all these pitfalls, success is being attained in the main: not ideal results perhaps, but very fair financial profit. The mistakes that have been made, the disappointments resulting from less acreage being irrigable by a given plant than the owner had anticipated, have been more than balanced by the phenomenal yields under reliable water-supply and thorough cultivation.

Seventy acres of alfalfa and orchard in Finney county, Kas., yielded, under one man's management, an income of $7,000; a neighbor reports $600 net income from five acres. Half an acre of Edwards county land, planted in onions and cabbage, paid its owner $200, besides "vegetables for family use not measured"; and another Edwards county farmer, who put in a $150 plant "too late, in June when the

THREE 10-IN. CYLINDER PUMPS BEING OPERATED BY ONE 16-FT. AEROMOTOR. PHOTOGRAPH SHOWS FRAME OF FOOT OF TOWER. F. W. RICHTER, GARDEN CITY, KANSAS.



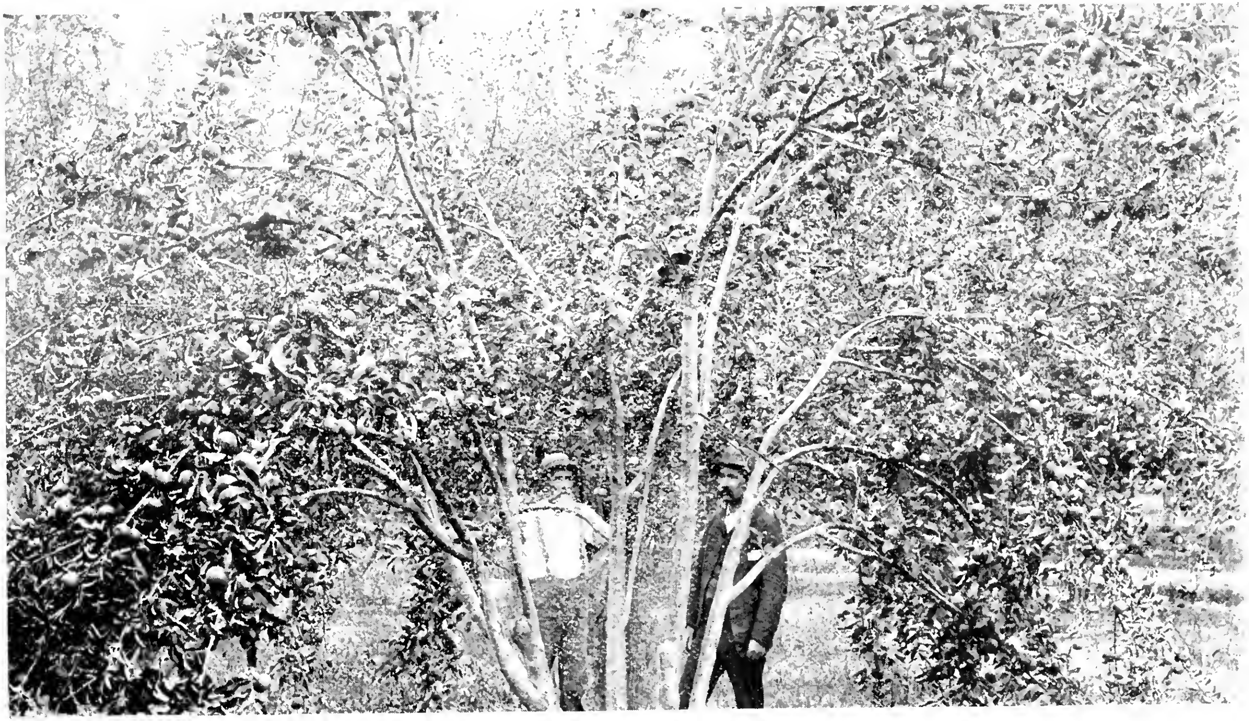
"MOGUL" OR "JUMBO" WINDMILL PUMPING INTO RESERVOIR. GARDEN CITY, KANS.

crops had begun to suffer," still obtained from one and one-quarter acres of potatoes and cabbage $400, "besides family supply." An orchard of 16 acres gives gross returns $375 per acre. Eight acres of small fruits yield $626 net per acre. Hundreds of examples might be cited of similar profits under intelligent management.

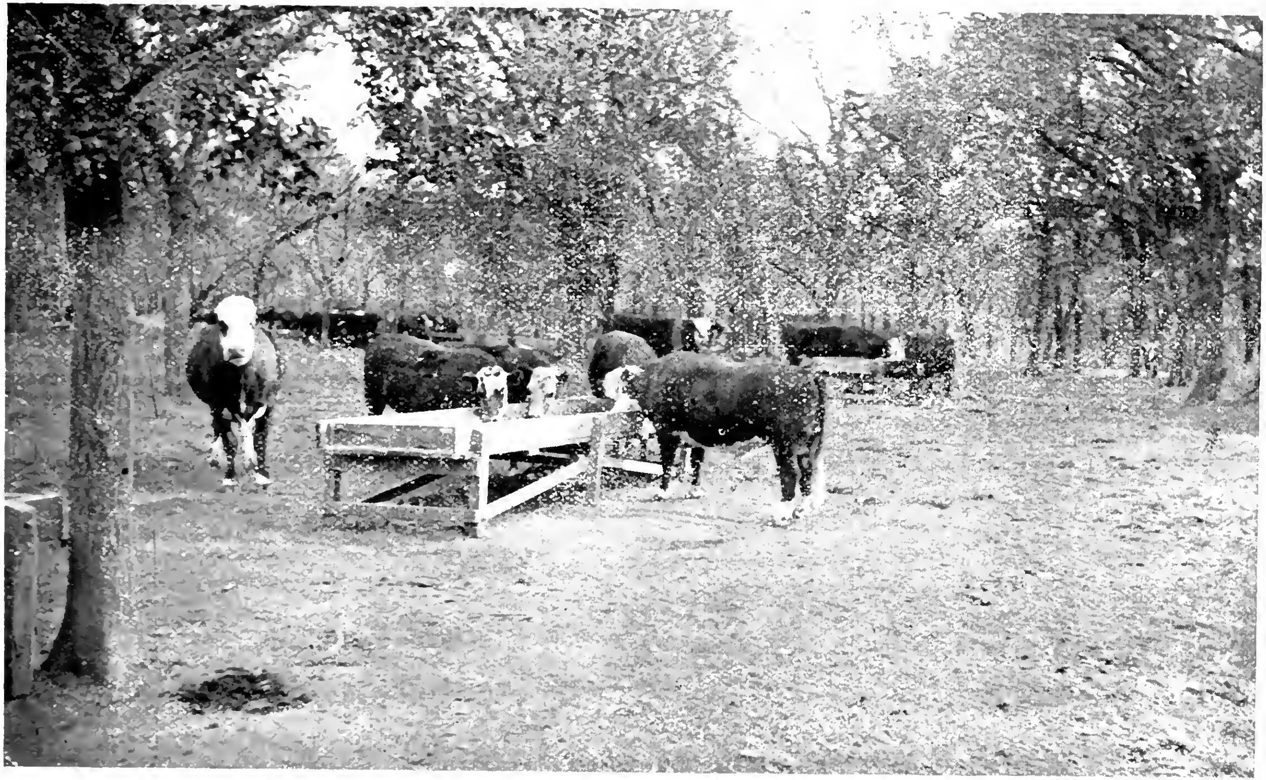
The selection of the proper plant and power for any given location should be determined by a careful study of the local conditions. By far the most popular pumping-machine on the plains is the wind-mill; that is to say, there are several times as many of these as of all other installations of pumping power combined. From the train at Garden City the traveler may descry seventy to one hundred wind mills, the reason for their great popularity, here as elsewhere, being that "wind is cheap." They are usually of the common radial-fan type, but so varying in detail that any average of their performance can hardly be determined. The brawn and brains of the farmer have even freer play to influence results under irrigation than they had without its aid.

It may perhaps be generally stated that mills from 10 to 16 feet in diameter, mounted on 30-to 40-foot towers, are successfully irrigating from 6 to 20 acres each with a 20-foot lift and from 1 to 3 acres each with a 150-foot lift; and that an investment of $150 to $300 is enabling the farmer to realize returns of $20 to $100 per acre.

Even this investment, with its assured reward, is, however, beyond the reach of many a struggling tiller of the soil who, perhaps, has lost crop after crop through a continually disappointed trust in a more reliable rainfall, until he finds himself forced by necessity to the adoption



SOME OF BARTLETT'S APPLES. GARDEN CITY, KANSAS.

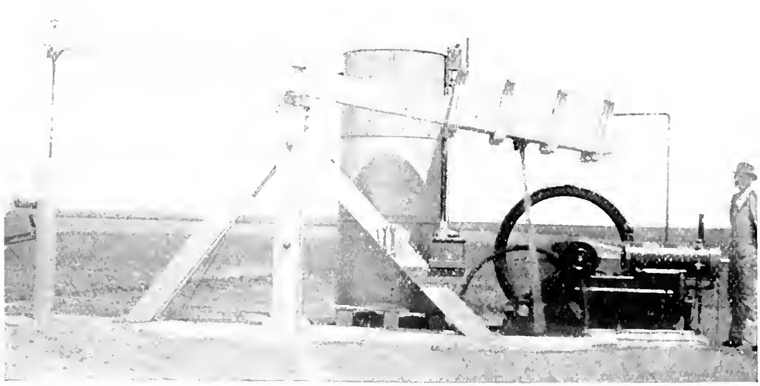


CORN-FINISHING CATTLE FOR MARKET. THE ALFALFA IRRIGATION AND LAND CO.

of irrigation, and yet unable to consult real economy in the purchase of proper machinery.

From some such situation as his arose the device of the "Mogul," a cheap substitute for the tower mill. The Mogul is practically an inverted undershot wheel, the shaft being horizontal and the lower half of the wheel being boxed around to keep off the wind, which thus strikes only the upper sails. It, is of course, set to catch the prevailing winds, which in Kansas are generally north or south, and is arranged to work equally well with either; but it diminishes rapidly in efficiency as the wind hauls toward the east or west, and is also at a disadvantage in that it catches only surface currents, which are always more sluggish than the breezes thirty or forty feet from the ground. Its only merits are cheapness and the possibility of construction by home labor. A Mogul 12 feet in diameter and 14 feet long, with eight fans 2 × 14, will irrigate from 1 to 2 acres with a 20-foot lift, and, if built new and all labor paid for, will cost from $100 to $200. If constructed (as it often is) by the farmer himself from old material on hand, the cash outlay may be as low as $25.

Contrary to popular opinion, however, cheap wind does not of necessity supply the cheapest power, and economy as well as efficiency may be best served by the substitution of other motive force. This hardly accounts for the occasional use of animal powers, geared to an endless chain carrying buckets, or for the belting of steam threshing engines to centrifugal pumps; such extraordinary devices may be passed over as makeshifts, ingenious and commendable as an exhibition



STATE PUMPING PLANT, GOODLAND, KANSAS.

10 "Actual H. P." Gasoline Engine, operating a 5½ inch cylinder with 36 inch stroke, in a 6-inch well, 170 feet deep, and raising, from the underflow, 6000 gallons per hour.

of determination in the face of obstacles, but destined to give way to something better.

The first place in order of mention among the applications of mechanical as distinguished from natural force may then be given to the gasoline engines, driving various forms of pumps; centrifugal or auger types for short lifts from creeks, ponds, or open wells; rotary pumps (positive) for longer lifts; and reciprocal, cylinder pumping engines for still higher lifts, as at the Goodland State pumping-station. These plants cost, complete, anywhere from $500 to $1,500, perhaps in the average approximating the lower limit more nearly than the higher one.

Above these again rank the compound duplex pumping engines for the higher duties, approaching in cost and capacity small or even medium-sized municipal plants. Such large installations, on account of the magnitude of the capital required for their equipment and

FINNEY COUNTY FAIR. GARDEN CITY, KANSAS.

operation, are naturally few in number, many even of those who could afford the outlay being disposed at present to wait until the results of others' experience have put the matter beyond what they are still inclined to consider an experimental stage; and yet, where they are installed, large plants are for obvious reasons much the more economical proportionately.

Where large power is required, however, the question of the source of energy is a serious one. Gasoline shows a tendency, with the rapid increase in its application, to advance in price; coal sells for $4 to $6 a ton delivered at stations on the plains.

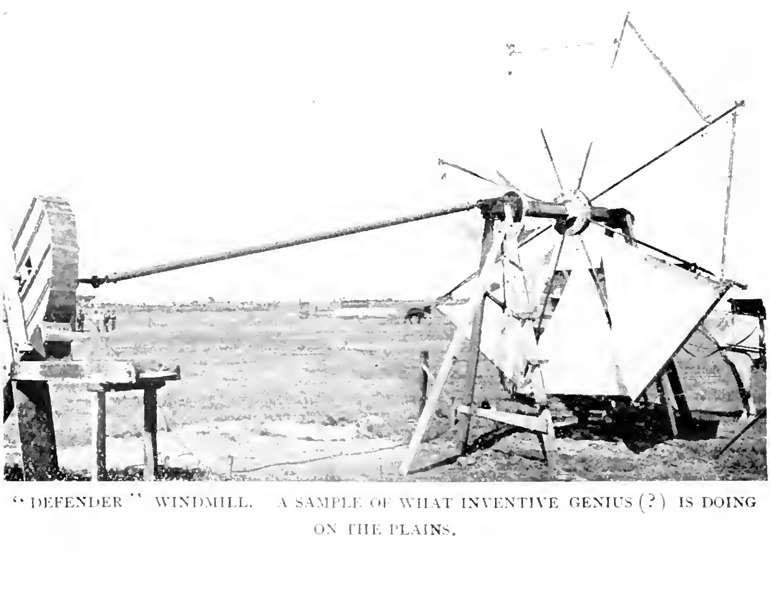
On the other hand, the free air is lightest and least available during the dryest months, when power is most needed. Only, the power of the sun seems to wax and wane in direct ratio to the need of water: who will enter this inviting field for inventive genius, and give us a

STACKING ALFALFA. F. W. RICHTER'S FARM, GARDEN CITY, KANSAS.

practical helio-motor, or other and more probably reliable source of power? He will reap a rich reward for his labor.

For, after all, pump irrigation, like many other things, is serviceable and desirable only if it can be made to pay. Mr. Geo. M. Munger, of Eureka, Greenwood county, Kans., has summed up the matter in a manner well worthy of quotation. Mr. Munger owns a steam pumping plant of 4,000,000 gallons, daily capacity, irrigating 500 acres, and therefore may well rank as an authority.

In a recent communication to the State Board of Horticulture, he says: "The question whether or not it pays is the vital one to be considered. Should a man obtain by irrigation 100 bushels of corn

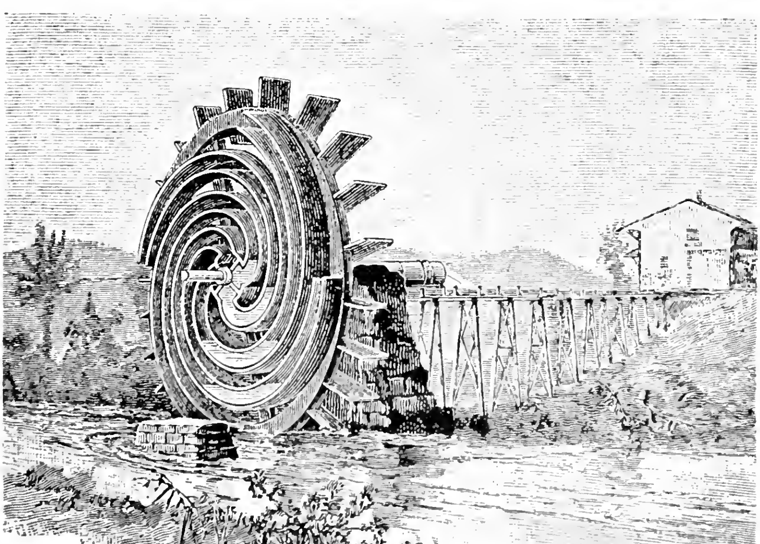


"DEFENDER" WINDMILL. A SAMPLE OF WHAT INVENTIVE GENIUS (?) IS DOING ON THE PLAINS.

per acre and get 15 or 20 cents a bushel for it, he would not be making headway very rapidly; but, if a man has a bearing orchard that is yielding an occasional crop of 50 to 100 bushels per acre, of which one-half to three-fourths must be classed as seconds or culls, and if, by irrigating that orchard, he can increase the crop to three times the quantity and have it all grade 'fancy,' it is easy to see that at any prices for fruits that have been known to prevail he could afford to spend a very considerable sum per acre to install an irrigation plant.

"Then if, in place of an occasional crop, the irrigation will give him regular annual crops of this class, it requires no bookkeeping to discover that it is profitable."

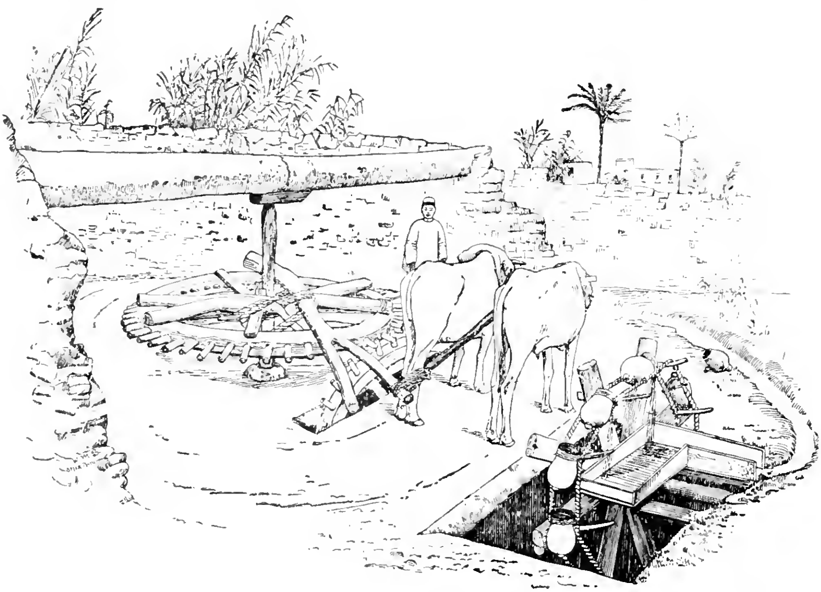
Crop.	Annual Returns.	Dollars Per Acre.	
	Average Bottom Land Not Irrigated.	Average Irrigated.	Best Results (Average) Irrigated.
Alfalfa hay and seed	$21	$36	$61
Alfalfa, hay only	14	23	36
Corn	5	11	24
Wheat	7	18	29
Potatoes	25	137	250
Sweet Potatoes	25	172	333
Onions	50	275	550
Small fruits	100	625	1100
Orchard	50	537	1000



EGYPTIAN "TYMPANUM"

What is actually being accomplished in average practice is exhibited in the foregoing tables, compiled from returns reported to the writer by a large number of intelligent irrigators on the western Kansas plains.

Even allowing for exaggeration or over-enthusiasm, the reported results would certainly seem to justify the erection of pumping-plants wherever water is found at the depth at which it ordinarily occurs in abundance. But let it not be supposed for a moment that irrigation eliminates from the farmer's work the elements of painstaking care and good judgment: on the contrary, it affords a larger field for their employment, and even demands their exercise in the highest degree,



A PERSIAN WATER WHEEL. ESTIMATED CAPACITY, 2000 CUBIC FEET PER DAY.

that the best results may be secured from the land under the improved conditions and the highest returns may be obtained from the additional investment.

The man who raises but one crop is wasting his opportunities; he who manages, on the other hand, to gather two harvests from the same ground, say by following early potatoes with late cabbage, is getting double value for his irrigation. On favorable soils also much can be done, by deep plowing and winter irrigation, to store up water in the subsoil; and a given pumping-plant may thus be made adequate to twice the acreage it could protect if it were called upon to furnish all the moisture necessary to preserve the crops through the dry season.

It is not conceivable that irrigation, even by pumping, can ever be made universally applicable. There ridges and high plains to which it would not be profitable, even if practicable, to carry a water-supply ; and these, in the region under discussion, must be reserved for alfalfa, some advantage which, though greatly improved by irrigation, can be grown to some advantage without. There will still be vast areas where no water-supply can be secured ; it may be that the total reclaimable acreage in the plains country will not exceed 15 per cent., or at most 30 per cent., of the entire area, very irregularly distributed, the possibility of irrigation ex tending perhaps to the entirety of some valleys and being wholly denied to adjacent ridges.

Within the irrigable area, however, the possibilities are almost boundless. The densest populations the world has known have been sustained upon an agriculture dependent upon irrigation. The semi-arid regions of Kansas and Nebraska, once filled with the promise and even the presence of prosperous cities, have suffered destitution and depopulation through the neglect of irrigation ; under the new order of things they are again stirring with life.

Abandoned homesteads are being taken up anew ; land companies, having developed a water-supply and secured large tracts of land from non-residents, usually in exchange for capital stock, are putting the hills into cattle ranges and the valleys into orchards and vegetable farms, into sugar beets and alfalfa, for development and tillage by new-comers, and the aforetime desolation is already fragrant with verdure andbudding with fertility.

Millions of acres of valley lands, now held at five to twelve dollars an acre, having under them the most reliable of all inland water-supplies, can be equipped with pumping-plants at a cost of five to ten dollars an acre, and irrigated at an annual expense of one to five dollars per acre ; and the resultant income can be made equal to ten per cent. on a valuation of one hundred dollars per acre, and often several times more. I am convinced beyond question that lands in the Arkansas valley, or any other valley having as reliable an underflow, are among the best investments in the country at present.

The day of the dry-farming lottery is passing ; crops are no longer to be scratched in upon unbroken lands by the square mile, but are being planted, subsoiled, and watered, and are yielding surely and abundantly. A maximum crop every year is far better than an occasional crop in the years when the rainfall is seasonable. Irrigation is the only insurance that provides against drouths, hot winds, and frosts, and repays annually to the policy-holder the full face of the policy ; and pump irrigation on the plains is the best and surest of all.

THE FUTURE OF ELEVATED RAILROADS.

By Eugene Klapp.

IT is questionable if any more elevated railroads will be built in the United States. The roads in New York have, of course, been a gold mine, and all others have been the outcome of attempts to duplicate the successes of those in New York without thoroughly weighing the conditions there existing. New York, a long, narrow strip of land which in parts is the most densely populated locality in the world, is served by four parallel lines of elevated roads, so arranged that there is hardly one of the entire population who is not within access of one or the other of them.

Very different is the case in Brooklyn and Chicago, where the population is much more scattered, and where the roads each represent but one spoke of a gigantic wheel; the further one goes from the center or hub, the greater the distances on either side which are inaccessible. The Brooklyn roads have been for a long time a great disappointment financially, while two of those in Chicago have already gone down beneath their burden of "fixed charges." It is true that in Chicago neither of the roads had adequate terminal facilities or approached near enough to the heart of the business district to successfully compete with the very excellent cable competition on the surface. This difficulty, already partially overcome on the Lake Street Road, will soon be completely effaced for all the Chicago roads by the completion of the "Union Loop," upon which all four elevated roads will have equal rights, and which will make them one of the most complete transportation systems of the world.

In Chicago a new element of trouble has been introduced by the purchase of a "right of way." This plan was first introduced by the "Alley L," so-called, and was in a great measure adopted because, by so doing, the road was enabled to get an ordinance through the city council, thus outstripping a rival which was asking for a franchise upon a public street only half a block away. The plan has since been continued by the Metropolitan and the Northwestern (under construction) on the ground that all damages to abutting property are thus settled in advance, and the road made comparatively free from the vexatious and very costly litigation to which the eastern roads are constantly subjected. On the other hand, it has increased the first cost and consequently the yearly interest account to an enormous extent, so that it certainly is questionable whether it is better to saddle a young and struggling road with such charges, or to defer them for five or six years, at which time the road, having built up its territory, would be better able to meet the expense.

Moreover, on the plan upon which most railroads are at present financed, this first cost for right of way must be met with money obtained from bonds placed at a ruinous discount and carrying with them a stock bonus almost sufficient in itself to pay the damages that may be adjudged in after years. Again, the Illinois law requires the petition of a majority of the "frontage on each mile of street sought to be used" before the council can act; hence a road constructed in a street under such circumstances has at least one half of the frontage estopped from any action for damages. For, though the case, so far as I know, has never been passed upon by any court, it does not seem in the bounds of common sense that a man can petition the council for a certain thing and then turn around and sue for damages, upon having his petition granted. Despite these drawbacks, however, there can be no question that, with the excellent terminal facilities afforded by the loop, and with the completion of a few short and very much needed branches into thickly-settled suburbs, all the Chicago roads will be on a secure and paying basis. The natural increase in population and the building up of their territories by reason of the unexcelled service the roads can give will in a few years unquestionably make them very valuable properties. It is clear that, if Chicago, whose population has increased beyond all comparison, can not without less difficulty support roads of the present character, then certainly no other city in the union can hold out any inducement for capital to originate such enterprises.

Yet there is many a city of moderate size where the business district is much congested and traffic and life endangered by the cable and electric lines, and where a few miles of elevated structure would greatly benefit all concerned.

These reflections have led to a thorough investigation of methods of cheapening the construction of elevated railroads, with a view to adapting them more generally to the use of smaller cities and at the same time to making them a financial possibility.

What is the origin of the present elevated railroad, and what has forced it into its present form of structure and equipment? When the first New York road was built in 1869 or thereabouts, there were but two forms of power,—steam and horse. True, the owners of this pioneer road experimented with a crude chain, using it somewhat in the manner of the modern cable, but so unsuccessfully as to cause its abandonment in a very short time. Horses being obviously out of the question, there remained only steam, which was consequently adopted as the motive power by necessity.

A steam motor requires two men to operate it; hence it is very much cheaper to run one train of four cars than two trains of two cars. To this consideration more than to any other one cause is due the present style of elevated railroad.

To operate such trains there is required a heavy motor with tractive force sufficient to haul four or five cars, which again necessitates a heavy and massive supporting structure.

In this way, then, and by reason of the phenomenal traffic which the New York roads soon secured, the present comparatively heavy train was developed, and has been copied by all the succeeding roads.

Some of the natural sequences of this method of equipment, however, are as follows: When the traffic is not heavy, not only are the cars cut off, but the interval is necessarily made longer, in order to make the saving which, as before indicated, is possible by using the larger and fewer units instead of the smaller and more numerous. Yet it is a well-recognized principle of successful street-railway management that small and frequent units not only take what business there may be, but seem almost to create it.

The result is that, instead of having an elevated street-railway, which is what most cities require, we have an elevated "trunk line," with trains of from three to five cars running during the less busy portions of the day at intervals of from five to seven, or even ten, minutes, involving a heavy, costly, and objectionable structure. When a man wants to ride a couple of miles, more or less, in a city, he does not wish to wait eight minutes for his conveyance while perhaps he sees four or five surface street cars going by during the same interval.

A comparison in train-crew wages by both methods of operation is shown in the following table, assuming both to be operated by electricity with but one man on the motor.

Cost of labor per 4-car train every six minutes:

HEAVY CARS.

1 Motor man,	\$2.50 per day.	\$8.10 per day.
1 Conductor,	2.00 " "	
2 Guards,	3.60 " "	

Seating capacity, 188. Weight of train, 87 tons.

Cost of labor per day for *three* 2-car trains at intervals of 2 minutes:

LIGHT CARS.

3 Motor men,	\$6.75 per day.	\$12.15 per day.
3 Conductors,	5.40 " "	

Seating capacity, 180. Weight of 3 trains, 48 tons.

Thus the cost of labor compels managers who have heavy cars to bunch them into large units. For the same carrying capacity the labor bills are as $8.10 is to $12.15. But against this the manager with light cars can place his smaller tonnage,—48 instead of 87.

Now, as it takes just as much coal to haul a ton of dead weight as a ton of passengers, it is clear that the saving in fuel and power-house equipment will be almost one-half. An elevated car weighs about 15 tons empty, and seats only 48 passengers. A surface street car weighing 4 tons will seat 26. In one case, 15 tons of dead weight to only 3 tons of live load; in the other, 4 tons of dead to 2 of live. Even if the above consideration in itself does not counterbalance the extra labor bill, which in many cases it will, there is always the saving in interest on the cost of the cheaper and lighter structure, besides the increased earnings due to better service.

The average speed may be raised on the lighter road, because its motors can be made to run just as fast for a maximum, while its stops and starts can be made much faster.

A comparison of the cost of construction per mile of road is shown in the following table. The gross figures for the heavy road are from the actual expenditures of two of the present elevated roads; the figures for the lighter road, given in detail, have been estimated with great care, and can be easily substantiated. The heavy roads were built mostly on a purchased right of way, while the lighter road is figured on the basis of the use of the public streets. The total actual cost per mile of a standard elevated road varies from $850,000 to $1,235,000, depending on the condition of the iron, labor, and money market, at the time of construction.

TABLE OF ESTIMATED COST OF LIGHT ELEVATED ROAD.

	One mile.		One mile.
Engineering	$ 5,555	Clerks	$ 1,111
Iron structure	52,000	Stationery and printing	200
Foundations	17,600	Contingencies	32,549
Track	22,222	Legal expenses	2,000
Stations	24,000	Taxes	555
Shops	2,777	Elevated yard	8,888
Tools and machinery	777	Power-house	16,660
Telegraph	111	Line	11,110
Motors	22,222	Bond expenses	1,666
Cars	22,222	Discount on bonds	25,210
Real estate for power-house and yards	13,333	Interest on bonds during construction	14,328
Office expenses	1,555		
		Total cost of one mile	$298,651

In the above estimate it is assumed that stations will be much closer together than is possible on ordinary elevated roads. At the same time they can be made very much less expensive to build, maintain, and operate. If there were five stations per mile, instead of only two, as is now usual, there would be a great gain of traffic from intermediate points.

The interest charges upon the above road would be five per cent. on $298,657.00, or $14,932.85 per mile of road against at least $42,-500.00 per mile of standard road! The following table of operating expenses per day shows the cost, in each case, of carrying the same number of people. The figures are compiled from the actual expenses of one of the standard roads during one year, and are altered only by the substitution of estimates for such items as would be affected by the substitution of electricity as a motive power, and by a reduction in station expenses made possible by the plan of operation adopted by the newest roads. The former are estimated on data from the practice of two or three large surface electric systems furnished to the writer. The endeavor has been to pick out from the practice of several standard roads all those points which seem to be best and most economical, in order to make the comparison as fair as possible.

TABLE OF OPERATING EXPENSES PER DAY.

Item.	Standard Road.	Light Road.	Saving.
General expenses including taxes, damages, legal expenses, etc	164	164	
Maintenance of way	75	60	15
Maintenance of rolling stock	77	77	
Motormen	133	172	—39
Powerhouse force	56	56	
Hostlers, wipers, etc	10	10	
Fuel	306	125	181
Water	23	10	13
Oil, waste, and tallow	4	4	
Conductors and guards	218	158	60
Yardmen, switchmen, and couplers	45	20	25
Inspectors and cleaners	28	28	
Ticket sellers	98	150	—52
Porters and laborers	28	20	8
Station supplies	19	9	10
Telegraph	21	21	
Interest on bonds	1,048*	371	677
Totals	$2,353	$1,455	$898

*Note—Interest figured at 5% on least cost of standard road, as figured above.

In the above table, where figures are estimated for the lighter road, they have purposely been made high in comparison with those for the other road, in order to be on the safe side. It will be seen, upon analyzing this estimate, that, of the total saving of $898 per day, only $221 is effected in operating expenses, the balance, $677, being due to saving in interest charges.

These figures are intended to cover all regular expenditures of any nature whatsoever, year in and year out, so that whatever difference there may be between the expense, $1,455 per day, and the income may be considered applicable upon the stock as a dividend. The cost of building the above hypothetical road at about $300,000 per mile would be $2,700,000. It is one of the claims herein put forth that a road constructed and operated upon the plan proposed would be better able to compete with adjacent surface roads and would carry more passengers, hence earning a greater revenue. But, assuming that the traffic were only the same as that of the standard road with which all the above comparisons have been made, the net earnings would be sufficient to pay a dividend of over seven per cent. upon the capital stock, providing the issue of stock was equal to the gross cost of the proposed road.

Conservative management might reserve three to four per cent. for extraordinary expenses. The structure would need repainting throughout once in every four to five years. The ties would probably last ten years, and the rails possibly fifteen, but some day the need of renewal would become pressing, and the money would have to be provided in some way.

Allowing, then, for this reserve fund, there is still left a fair interest for the stock, with the prospect of getting whatever increase in earnings the road might show, when provided with proper terminals and branches. Now, as before stated, the standard road will eventually do as well as this, and some day even better; but it is far from doing so to-day, and can only gradually arrive at the point where a light road would have been already.

It may be objected that such a road cannot have the ultimate capacity of the larger and heavier road. This is by no means certain, as the cars or trains, being so light and easily stopped, can be safely run much closer together. The number of people carried each day on some of our various cable and trolley roads is enormous,—so large, in fact, that, should the capacity of the road ever be reached, it would have already fulfilled its mission as a gold mine, and its owners could well afford to double up the tracks, or build a parallel road on an adjacent street.

The future, therefore, of elevated roads cannot lie in the beaten track of the present practice; but there are few cities of the second or third rank that cannot aspire to supporting one or more elevated roads planned and constructed somewhat on the lines suggested. Only in this way can the safety and convenience of their streets be assured.

THE RELATIVE VALUE OF DIFFERENT COALS.

By H. M. Chance.

WHEN used to produce heat, the value of coal depends upon the quantity of heat obtained from it. This is the chief function it performs, and the one this article proposes to discuss. Its use as a metallurgical agent for reducing or smelting metals from their ores, and for the working and manipulation of metals, constitutes a distinct field subject to conditions which cannot be here defined.

From one pound of good coal enough heat can be obtained to evaporate a little more than a gallon, say five quarts or ten pounds, of water. If, with such a coal, another be compared which will evaporate but two and one-half quarts, or five pounds, of water, the thermal value of the second coal is said to be one-half that of the first.

The relative thermal values of coals are, therefore, their relative capacities for producing heat, and it is evident that commercial values should be proportional to these thermal values.

In determining thermal values, the scientist or physicist deals, or attempts to deal, with the whole amount of heat produced by the complete combustion of a given quantity of fuel, including the heat escaping with the waste gases through the chimney, that lost by radiation and even that carried away in removing the hot ashes.*

As in practice much of this heat is necessarily lost through radiation and imperfect combustion, some carbon going off as smoke or soot and some combustible gases escaping unconsumed, we cannot adopt the scientist's standard for practical work. Hence we take as a measure of value the actual heat utilized, as shown by the quantity of water evaporated by each pound of coal under the conditions present at any particular steaming plant, the thermal values so determined indicating the real value to the consumer of the coals under consideration.

When fuel-cost forms a large item in the total cost of production, the value of coals is often the subject of careful experimentation.

* The thermal unit used in this country and Great Britain is the quantity of heat necessary to raise one pound of water one degree Fahrenheit. The French thermal unit, in general use by scientists of all countries, is the quantity of heat necessary to raise one gram of water one degree Centigrade. The thermal unit commonly used in comparing the value of coals is the number of gallons of water evaporated by one pound of coal.

Practical trial runs are made with different coals to determine under existing conditions which coal gives the best results at the lowest relative cost. The results of such tests often develop the fact that personal judgment in such matters, unless based upon actual figures, is of little value. I have in mind a simple little case of this kind, where the choice of fuels was between two pea (anthracite) coals, one of which was better, but also higher-priced, than the other. The judgment of the fireman and engineer was that it did not pay to buy the cheaper fuel, that the plant took "one-third more coal" when using it, etc.; the actual figures for equal work were:

100 tons Pea coal.....@ 3.50............$350
108 " " " .....@ 3.00............$324

When careful records are kept of the coal consumed and the water evaporated or work turned out, the relative values of any coals can be reliably determined by trial, but such tests are expensive and troublesome, involving the cleaning-up of all coal remaining on hand, with perhaps more or less trouble in making steam with the new fuel until the firemen learn its peculiarities. Hence the consumer is generally averse to experimentation or change, and, unless fully convinced that the new article is much better or much cheaper than the old, cannot be persuaded to try it.

A change in fuel is especially obnoxious to most firemen. Protests from both firemen and engineers may be expected, whenever the fuel is changed, whether the change be from a poor to a good fuel, or *vice versa*. They arise from the fact that the thermal value of a fuel at any plant—*i. e.*, the water converted into steam—depends largely upon the conditions present at that plant, and also upon the method of firing and the knowledge, versatility, and integrity of the firemen using it.

An instance illustrating this feature occurred in the experience of the writer, who was consulted regarding the fuel-supply for a steaming plant consisting of about a dozen isolated boiler plants consuming in the aggregate about one hundred tons of coal per day. The fuel in use was a good coal, but, as it contained much gas, was "sooty" and fouled the boiler tubes, notwithstanding frequent scraping and blowing out. Consequently the fires were being forced nearly all the time, and the economy of the plants as steam producers was correspondingly low. As a result of the conference, the writer was authorized to contract for a supply of fuel better adapted to the requirements of the plants, and at once secured a quantity of one of the best bituminous coals coming into the Atlantic seaboard market,—a fuel famous upon the transatlantic liners. This fuel contained less gas and deposited little soot in the tubes. Nevertheless, upon the arrival of that coal, trouble arose at every plant: protests came in from almost every engineer and fireman. They stated that they simply could not make steam; that the coal was miserable stuff, "contained no gas," "made no flame," etc. At one plant, where a delayed shipment of the former coal was received after the delivery of the new coal had commenced at the other plants, the firemen sent in the same protest,—they "could not possibly make steam with the new (?) fuel"! In about a week the complaints practically ceased, and more steam was made at all the plants with less fuel than before the change.

The writer also recalls a similar experience with the firemen of a railway where a change in fuel was met by protests from all parts of the system, which, however, quickly subsided when the men had learned how to handle the new fuel and realized that it was better than that formerly used.

As the thermal value of a fuel, as determined under the ideal conditions required for scientific test, is never realized or even approximated in practice, the consumer is interested only in the relative thermal values as developed under average conditions at his own plant. And the conditions at different steaming plants vary so widely that the best and cheapest fuel for one plant may be a very unsatisfactory and costly fuel at another. Some of the best coals produce light, fine, even pulverulent ash, which, as burned under some boilers with horizontal tubes, quickly clogs up the tubes and greatly reduces the economy and capacity of the plant; under such conditions an inferior coal may produce better results, while, in a plant with vertical tubes or in a highly-inclined water-tube boiler, the results would be very different. The same conditions affect the thermal values of coals with large percentages of gas, and of coals yielding a very rich or smoky gas. Here it becomes a question of grate area, thickness of fire, size and arrangement of combustion chamber, and admission of air above the grate. If these conditions are not adapted to the coal, no possible amount of scraping and blowing-out of the tubes will keep them clean enough to give satisfactory results with such a fuel, and better results may be attained with a much poorer coal of different character.

It may, however, be asserted at the outset that conditions causing in practice such abnormal relative thermal values should be regarded with suspicion, and it is safe to predict that, where such conditions obtain, it is entirely possible, in a majority of cases, to so correct the management, construction, or arrangement of the plant as to make it produce results consistent with the real values of the fuels used. At the same time we should remember that what may prove a faulty and wasteful design for burning one kind of coal may be capable of developing the highest efficiency from another variety.

The problem usually presented is to determine not what grate and boiler setting will develop the best results from the best fuel at the lowest relative cost, but, given a particular boiler with fixed grate and boiler setting, which of several available coals will give the best results at the lowest relative cost. The coal answering these conditions is the best fuel for that particular plant.

As it is manifestly impossible for each consumer to experiment with all of the numerous grades and varieties of coal in the market, a quick and ready method is needed for determining what grades will justify trial. If he is an expert judge of coal, much can be learned from an inspection of the coal, and many grades may be rejected at sight because of the visibly large quantity of slate or sulphur present. If he is not an expert judge of coal, the consumer may profitably be guided by the established reputation, or lack of reputation, of any coal. But the composition of the coal, as shown by chemical analyses, is the best criterion, care being taken always that the analyses represent properly-selected average samples.

In analyzing coal, the chemist first drives off the water by evaporation, by heating the coal to 212° or 225° F., the loss of weight giving the percentage of water. The coal is then heated to a red heat in a covered crucible, thus driving off the gas, which is the volatile combustible hydrocarbon, usually called by the chemist "volatile matter," the loss of weight giving the percentage of this constituent. The sample is next heated to a bright red heat in an uncovered crucible, the admission of air to which permits the carbon (coke) to burn, leaving only the ash behind, the loss of weight showing the percentage of carbon,—called "fixed carbon" by the chemist,—and the residue the percentage of ash. A separate analysis is necessary to determine the percentage of sulphur, which is deducted from the percentages of volatile matter and fixed carbon, already determined, as a part of the sulphur escapes with the volatile matter and the remainder burns off with the carbon.

The valuable constituents of coal are its carbon and hydrocarbon (volatile matter) contents; the waste matter consists of water, ash, and sulphur.

Other things being equal, coals with high percentages of volatile matter have greater ultimate thermal values than coals with small percentages of volatile matter. The relative thermal values of the carbon of coal and of the volatile matter are about as eight is to fourteen. Assuming for comparison two coals, one with 75 per cent. of carbon and 20 per cent. of volatile matter, and the other with 55 per cent. of carbon and 40 per cent. of volatile matter, the theoretical thermal values are in the ratio of about 8.80 to 10; but such differences are not obtainable in ordinary tests, much less in actual work, owing to the large loss of heat due to unconsumed gases, to imperfect combustion (always experienced in using coals with a high percentage of volatile matter), and to the difficulty of effecting anything like complete combustion of the gases, some of the hydrocarbons being burned only to carbonic oxid (CO) instead of to carbonic acid (CO_2), with a development of less than one-half the heat which would be produced by complete combustion.

Hence, while the law remains that the thermal value of a coal rises with the percentage of hydrocarbons (volatile matter), it will not do to apply this law to present practice. In fact, the bituminous coals, from which some of the best steaming results are obtained, are those coming into the Atlantic seaport markets, which carry a comparatively low percentage of volatile matter,—say, from eighteen to thirty per cent.

The more perfect combustion and cleaner boiler tubes which can be maintained when burning anthracite enable the consumer to realize a high thermal value from it, notwithstanding the small percentage of volatile matter which anthracite coals contain.

By adding together the percentages of volatile matter and fixed carbon, we obtain the percentage of combustible matter contained by any coal. Coals with high percentages of combustible matter generally have higher fuel values than coals with low percentages of combustibles. Prices should not vary widely from the relative quantities of combustible matter.

A coal with 90 per cent. of combustibles means a coal with 1,800 pounds of combustible matter and 200 pounds of waste matter in each ton; a coal with 80 per cent. of combustibles has 1,600 pounds of fuel and 400 pounds of waste matter in each ton.

Few coals contain more than 90 or 92 per cent. of combustible matter. The combustible matter in high-grade coals may be taken as ranging from 88 up to 95 per cent.

The accompanying table shows the typical composition of high- and low grade anthracite, semi bituminous, and bituminous coals.

HIGH-GRADE COALS.

	Anthracite.	Semi-bituminous.	Bituminous.
Water	1.00	1.00	1.00
Volatile Matter	5.00	18.00	40.00
Fixed Carbon	88.50	75.50	53.50
Sulphur	.50	.50	.50
Ash	5.00	5.00	5.00
	100.00	100.00	100.00

LOW-GRADE COALS.

	Anthracite.	Semi-bituminous.	Bituminous.
Water	2.00	3.00	4.00
Volatile Matter	5.00	15.00	34.00
Fixed Carbon	75.00	67.00	46.50
Sulphur	2.00	3.00	3.50
Ash	16.00	12.00	12.00
	100.00	100.00	100.00

When the relative values determined by actual use vary widely from the values indicated by the percentages of combustible matter, it is advisable to examine closely into the arrangement, condition, and management of the plant; for it is evident that the plant is wasting more heat with some coals than with others, and the cause of this may be remediable, and its recognition and rectification will probably lead to higher efficiency with all coals.

While the consumer may, therefore, rely upon the results of analyses in determining whether, at the price asked for it, any coal will justify its experimental use for the purpose of testing its true value to him, depending principally upon the percentages of total combustibles as shown by the analyses, the character of the impurities is also a factor of much importance.

Each one per cent. of water shown by the analysis means twenty pounds of water to the ton, and a coal showing five per cent. of water will, therefore, contain one hundred pounds of water to the ton. Before the coal can burn, this water must be evaporated by the heat of the fire, thus causing a waste of heat that would otherwise be available. To evaporate one hundred pounds of water will require the heat generated by the combustion of ten or fifteen pounds of coal. Hence the presence of one hundred pounds of water is equivalent to a reduction in the combustibles in each ton of one hundred and ten or one hundred and fifteen pounds.

The low thermal value of many western coals, and especially of the western lignites and lignitic coals, is principally due to large percentages of water,—the range being from about five per cent. up to twenty-four per cent. of water.

Large ash percentages are objectionable, not only because they reduce the quantity of combustibles per ton, but because of the increased cost of labor in firing and in removing and disposing of the ashes, and also because of losses occasioned by the frequent cleaning of fires necessitated by high ash coals.

The character of the ash is also of considerable importance. If easily fusible, it quickly closes the interstices of the grate, burning the grate-bars and necessitating frequent cleaning of the fires, with inevitable waste of fuel and chilling of the boilers. If the ash contains large pieces of slate, frequent cleaning, with much loss of coal, can be predicted. Coal yielding a fine pulverulent ash is unsatisfactory under conditions already described.

Because of the damage sometimes done to grates, boilers, settings, and stacks by coal containing a large percentage of sulphur, this impurity is very generally regarded as the most objectionable constituent of coal.

Few coals contain less than one per cent. of sulphur; in many the sulphur rises to two or three per cent.; while some coals much used in the west contain as high as four per cent., or more, of sulphur.

When injury from sulphur is detected, inquiry is generally instituted at once to determine how much sulphur the coal in use contains. If it be found that the coal contains only a small sulphur percentage, the damage is regarded as unavoidable, perhaps no complaint is made, and the fact and cause of damage never gain publicity. Should, however, the coal used be found high in sulphur, the damage is at once attributed to this cause; the miner or agent is censured for shipping inferior fuel, perhaps not up to contract stipulation: that concern loses a customer; and the circumstances and supposed cause of the difficulty become more or less generally known to all those directly and indirectly interested. In this way the sale of many coals has been ruined, perhaps justly, possibly unjustly.

As with many other objectionable things, the injurious effects of sulphur are dependent not so much upon its quantity as upon the form in which it exists in coal, and the manner in which the coal is used, and possibly upon the nature of the structural materials with which it is brought into contact.

Coal containing large quantities of sulphur in the form of iron pyrites is unquestionably hard on grate-bars. On the other hand, high sulphur coals are used in some districts with merely nominal damage from this cause. The subject is one not thoroughly understood, and must have careful investigation before it will be safe to make any very positive assertions regarding the action of sulphur in coal.

Meanwhile, in the light of present and past experience, it will be safe to give those coals the preference that show only moderate percentages of this impurity, for it is without doubt the most objectionable element contained in coal.

THE PRESENT STATUS OF AERIAL NAVIGATION.*

By Octave Chanute.

WHEN the writer about four years ago published an article in this magazine on "Progress in Aerial Navigation," † attempting to review the state of the art, and reaching the conclusion that it was now reasonably prudent to experiment, consideration of the subject was just emerging from public incredulity, and there seemed to be but little assurance of any more rapid progress in performance than during the preceding fifty years.

But there seem to be periods of increased activity in the development of particular problems, when they attract the simultaneous attention of competent men, and when knowledge advances by leaps. This has occurred with regard to aerial navigation since 1891, and, while commercial success cannot yet be said to be in sight, there are good reasons for believing that such progress has been made as to warrant hope that men will eventually fly through the air. It is proposed here to state briefly what has been recently accomplished.

It is known that the best achievement thus far made public concerning navigable balloons is that of Messrs. Renaud and Krebs of the French war department, who obtained in 1885 speeds of fourteen miles per hour with the war balloon "La France." This was insufficient to stem most of the winds that blow, but the French aeronautical establishment has since been spending large sums,—$80,000 some years,—partly to determine the best forms to give to such vessels in order to evade air resistance, and the best shape for propelling screws, and partly in experiments upon light motors; so that it was given out in 1893–4 that the French had constructed a new war balloon, the "General Meusnier," which was expected to develop a speed of twenty-five miles an hour, and carry fuel and other supplies for a ten-hour trip. It was to have been tested in the summer of 1895; but, if any such trials were made, they must have been carried on at night, as no public information has been given out, probably to avoid disclosing the secret of such a war engine. An international com-

* We are indebted to Mr. James Means, editor of *The Aeronautical Annual* for 1896, for the very excellent illustrations which accompany this article. The volume edited by Mr. Means will be found both interesting and valuable to everyone concerned with the subject of aeronautics. It is published by Messrs. W. B. Clarke & Co., Boston, Mass., and its price is $1.00.—THE EDITOR.

† THE ENGINEERING MAGAZINE, October, 1891.

petitive trial of navigable balloons is, however, set down as a feature of the French Exposition of 1900, with strict regulations to prevent photographing.

There is little doubt among experts that the speed announced will be realized, but meanwhile other European governments have taken up the research. and England, Germany, Russia, Italy, Portugal, and perhaps other countries, have established aeronautical departments, which are experimenting with both captive and war balloons, so that the next European war will probably make it known that the problem of military balloon propulsion has been approximately solved. This will almost certainly be the case if France and Germany are engaged against each other, the latter nation having, it is said, recently made great advance in the art inaugurated by its rival.

Even in the United States, the subject has attracted legislative attention. A bill was introduced in the senate in 1893 by Mr. Cockrell, offering a reward of $100,000 to any inventor, from whatever part of the world, who should, by January 1, 1900, construct a vessel which should demonstrate the practicability of safely navigating the air at a speed of not less than thirty miles an hour, and capable of carrying passengers and freight weighing at least five tons.

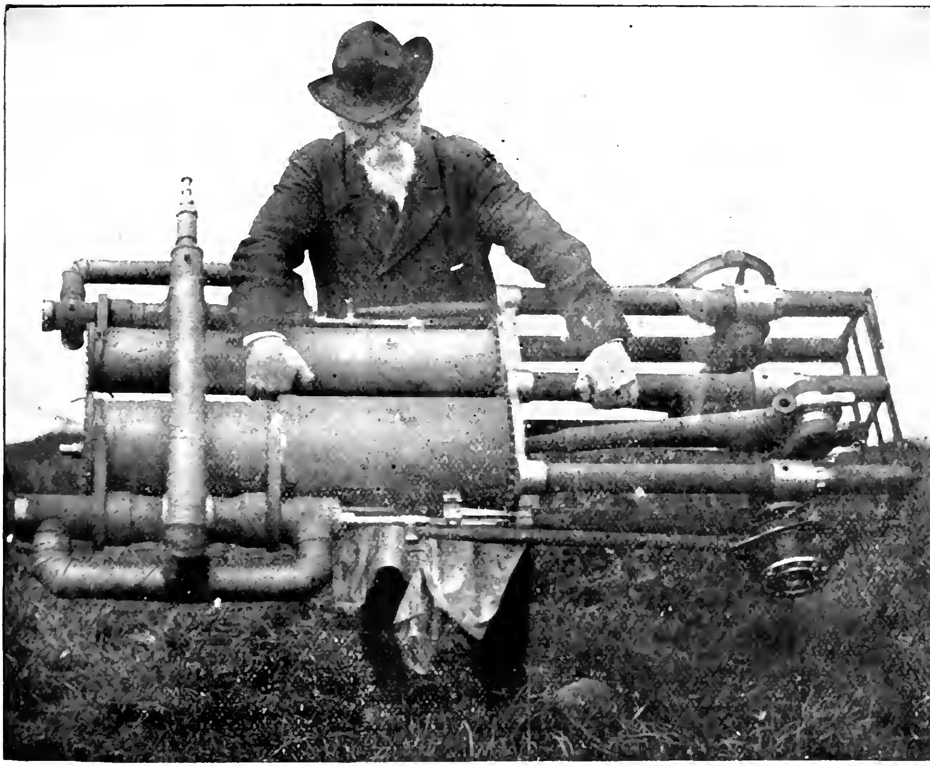
This was reported upon in 1895 by Mr. Brice, from the committee on interstate commerce, indicating that the reward would probably be earned, perhaps by more than one inventor, but that, in consequence of the then condition of the treasury, it was not advisable to pass the bill. It is said to have been reintroduced in the present congress by Senator Lodge.

It is, however, now pretty well understood that navigable balloons are so frail, carry so small cargoes, and attain so low speeds, that they are not likely to compete commercially with other means of transportation; but they doubtless will prove useful in war and in exploration, and the mere fact that a committee of the senate has reported on the bill above mentioned marks the advance recently made toward a solution of the problem.

In view of the recognized limitations of the navigable balloon, increased attention has been given of late to flying machines proper, which are sustained, like birds, by impact upon the air, and which promise speeds varying from sixty to one hundred and fifty miles an hour. In this direction great advances have been accomplished during the past four years, and men of the highest scientific and mechanical ability have given their thought, time, and money to experiment.

And first must be mentioned Professor Langley of the Smithsonian Institution, who published in 1891 his "Experiments in Aerodynamics," in which he gave the results of his experiments with planes, confirmed the empirical formula of Duchemin concerning air resistances, and enunciated the law that, within certain limits, high speeds through the air will be more economical of power than low speeds.

These labors gave data to searchers in this department of physics, and made it evident that aviation is not a utopian idea. It is said that farther experiments by Professor Langley have confirmed his opinion, then expressed, that better results can be obtained with curved surfaces



MR. MAXIM HOLDING ONE OF HIS ENGINES FOR THE PHOTOGRAPHER.

than with planes, and it is to be hoped that he will also be able to show how equilibrium is to be obtained in the air.

About the same time (1890) Mr. H. S. Maxim, the celebrated inventor, carried on for himself and quite independently experiments in air reactions analogous to those of Professor Langley, and he came to practically the same conclusions concerning them. He then designed, built, and developed a steam engine of extraordinary lightness in proportion to its energy, so that he demonstrated in 1894 that he had an engine of three hundred and sixty-two horse power, weighing, with its boiler, condenser, and adjuncts, less than eleven pounds to the horse power,—say one-twentieth as much proportionately as the most powerful locomotives, and less than the relative weight which is thought to obtain in the motor arrangements of birds.

This was applied to an aeroplane, spreading 4,000 square feet of surface, capable of increase to 5,500 square feet, the whole apparatus weighing 8,000 pounds. In a trial trip on July 31, 1894, the machine was accidentally released from the upper guiding rails, and it actually

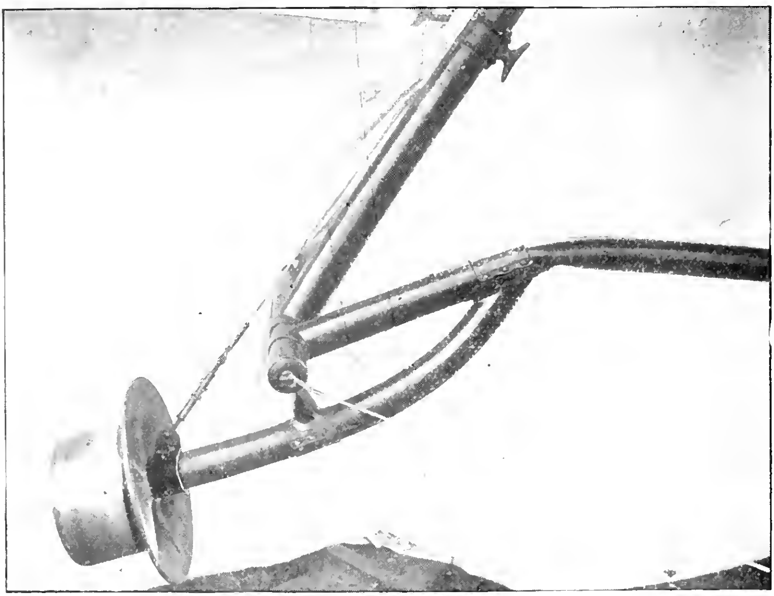


Fig. 12.

THE RESULT OF AN ACCIDENT TO MR. MAXIM'S MACHINE.

This shows one of the wheels which pulled upward on the upper rail. The lifting power of the machine caused the axle to yield as here shown.

flew a short distance. This flight being accidental, the machine soon came down and was broken in alighting, but the passengers received no injury.

The present machine is probably defective in equilibrium, and the condenser may not be adequate for a journey, but there seems to be no reason to doubt that these defects can be remedied, and that sufficient lifting power can be obtained with the motor already developed. Whether this be accomplished by Mr. Maxim, or ultimately by some-

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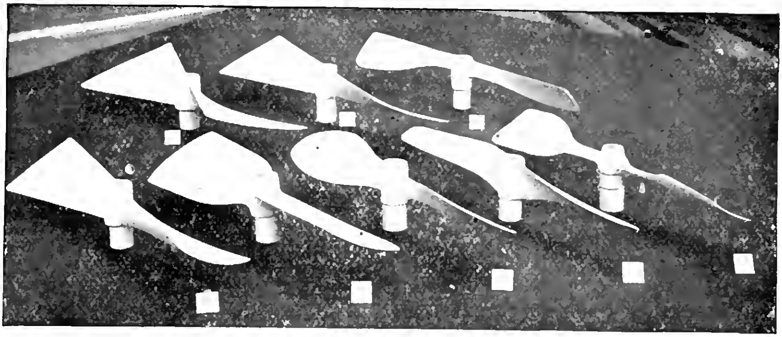
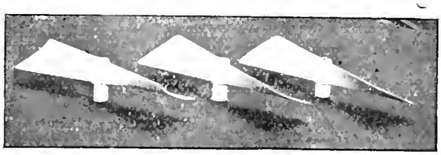


H G F E D

Fig. 13. — A group, showing the various forms of screws which Mr. Maxim has tested. The screw J was found to be the most efficient. A similar screw K, with wider blades, did not do so well. The screw E, although very light and small, did very well. G a screw made on the French plan, proved the worst screw experimented with. H, the same form as J, except that the blades are much thicker, also did remarkably well.



C B A

Fig. 14.

THE THREE PRINCIPAL FORMS OF SCREW EXPERIMENTED WITH.

A. — Plain screw with flat blades.
B. — Screw with slightly curved blades with increasing pitch.
C. — Screw with curved blades, compound increasing pitch.

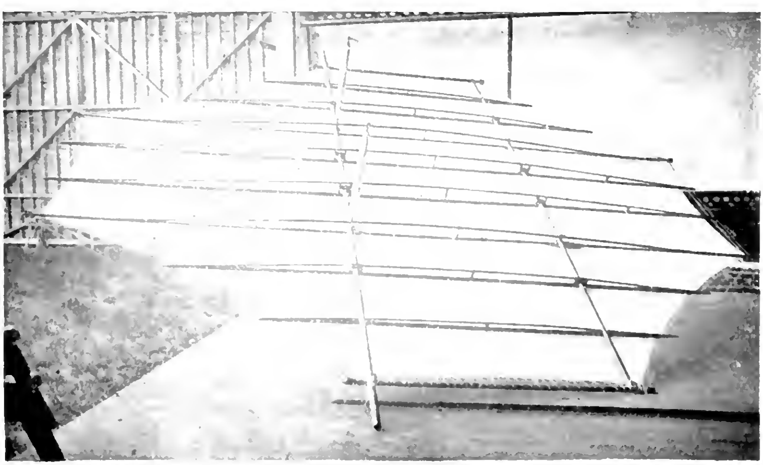


Fig. 15.

THE FORWARD RUDDER FOR STEERING MR. MAXIM'S MACHINE IN A VERTICAL DIRECTION.

This plate is especially interesting as showing the construction of the framing. — Ed.

body else, the former will have the renown of having produced the lightest steam engine ever built upon a large scale, and of having made it possible for man eventually to fly through the air with such a motor when the problem of safe stability is worked out. He is understood to be now contemplating the construction of a smaller apparatus.

Mr. Laurence Hargrave, now of Clifton, New South Wales, has accomplished great progress. He has built altogether twenty-one different model machines, all of which fly, and he has now produced a small steam engine weighing about eleven pounds per horse power. He has also produced a new form of aeroplane, which he terms a "cellular kite," by the use of two of which he has risen into the air when they were grouped in tandem above each other and restrained by a rope. He reports them to be perfectly stable and safe, and is now designing and building a full-sized flying machine.

In 1891 Herr Otto Lilienthal, a manufacturer of steam engines in Berlin, began a series of experiments in gliding flight with an apparatus of his invention. During the preceding twenty years, he had made many experiments, and had established the hitherto unrealized fact that surfaces shaped like the wings of sailing birds, when meeting the wind at small angles of incidence (3° to 10°), support some three to six times as much as planes of equal area at the same angle of incidence, while their forward resistance is not only less, but actually changes to a propelling component at acute angles. This discovery did much to correct the impression that enormous surfaces would be required to sustain the weight of a man, and made it apparent that an apparatus proportioned as is a sailing bird—*i. e.*, with one half to one square foot of surface per pound of weight—would probably suffice.

Herr Lilienthal then reduced his discovery to practice by utilizing gravity as a motive power, and gliding downward against the wind upon his apparatus from various heights, some hills utilized being two hundred feet high, and the longest glidings some four hundred yards. During several of these experiments he was lifted up by the wind as high as his original starting-point.

Having become expert at gliding downward, and having learned how to manage his apparatus, he next added a pair of propelling wings in front, moved by a compressed carbonic acid gas motor; and, having built an artificial conical hill, 50 feet high, near Berlin, he tested the new machine in the summer of 1894.

This modified apparatus did not perform to Herr Lilienthal's satisfaction. The motor was a complication, and the stability was not perfect. During the season of 1895 he modified the gliding apparatus by superposing one surface upon another, the connections forming keels, and with this arrangement he was enabled to increase his sup-

Fig. 3.

Fig. 4.

Fig. 3. Double form of apparatus constructed by Herr Otto L[illegible]. [illegible] about [illegible] square feet, or, a bearing surface of about 1[illegible]4 square feet [illegible]

Fig. 4. Shows manner of changing center of gravity, and particularly [illegible] to the left in order to press down the left wing, which is a little raised.

porting surfaces to 194 square feet, while reducing the spread to 18 feet. The results showed this to be a great improvement.

Herr Lilienthal also experimented in 1895 to determine the best profile for the wings, and he believes that these improvements have added so much to the stability of his apparatus that any one can learn to use it, so that downward gliding flight is likely to become an interesting sport. He has sold a number of the first types of his machines in Germany, Austria, France, and England, but the purchasers have found some trouble in learning how to manage them.

Mr. Herring, in the United States, produced in 1891 a flying model driven by twisted rubber, which automatically regulated itself in horizontal flight. In 1892 he applied the same principle to a larger model driven by an oil engine and provided with a condenser, which would raise itself into the air after running over a smooth horizontal surface. This having been destroyed by an accident, he next designed a gliding apparatus, somewhat similar to Lilienthal's, with which he took short flights: and in 1895 he produced a compact form of efficient supporting surface which seems to promise great stability.

Mr. Pilcher, in England, produced in 1895 two soaring machines, differing somewhat from Lilienthal's in design. With these he has been lifted from the ground twenty feet, and taken over a surface of two hundred or more feet, and he is now engaged in the construction of two new soaring machines,—one with an area of three hundred square feet for calm days, and one with one hundred and seventy square feet of sail, with which he is to experiment in 1896.

Mr. Mouillard, of Cairo, Egypt, who has been watching the sailing birds for forty years, has completed a full-sized soaring machine with over three hundred square feet of sail surface. With this he hopes to imitate all the manœuvres of the sailing birds and to maintain the equipoise automatically. The experiments are to begin soon.

Concurrently with these various experiments, the scientific features of the subject have been studied. A conference on aerial navigation took place in Chicago in 1893, the proceedings of which form a closely-printed volume of four hundred pages. An aeronautical club has been organized in Boston, and an aeronautical annual was published by Mr. Means of that city in 1895, which is continued in 1896, while many articles on the subject have appeared in the pages of the *American Engineer*.

It is thus seen that there has been remarkable progress since 1891. Incredulity has given way, and many keen intellects have been attracted to a study of the problem. The question which now presents itself is: what direction in further experiments promises the earliest solution? There are two paths open, both of which are indicated

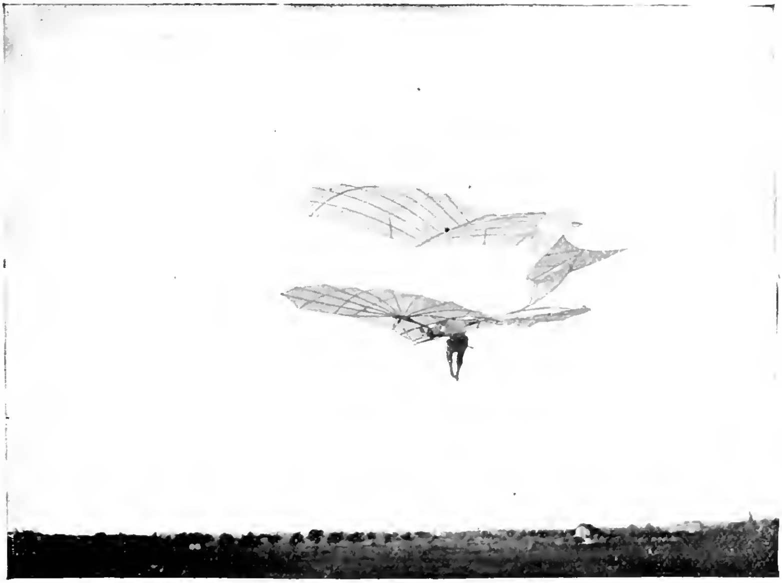


Fig. 5.

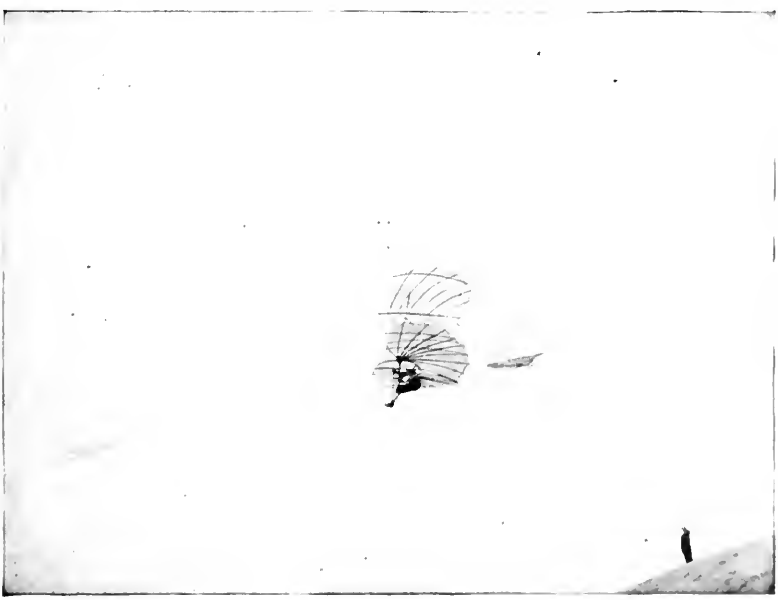


Fig. 6.

Fig. 5. Shows opposite movement to that shown in Fig. 4.

Fig. 6. The flights undertaken by such double sailing surfaces are distinguished by their great height. Left view of apparatus.

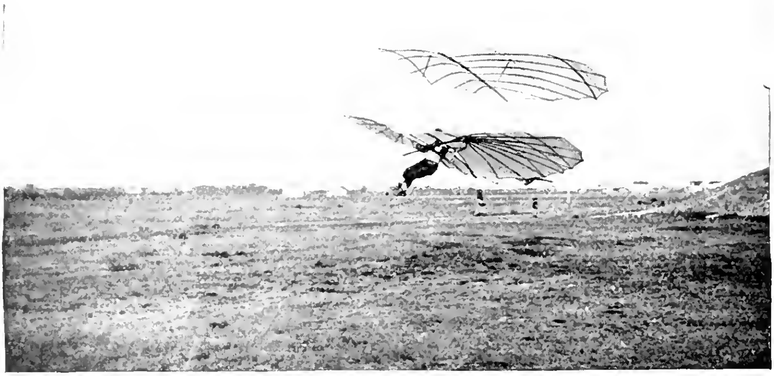


Fig. 7.

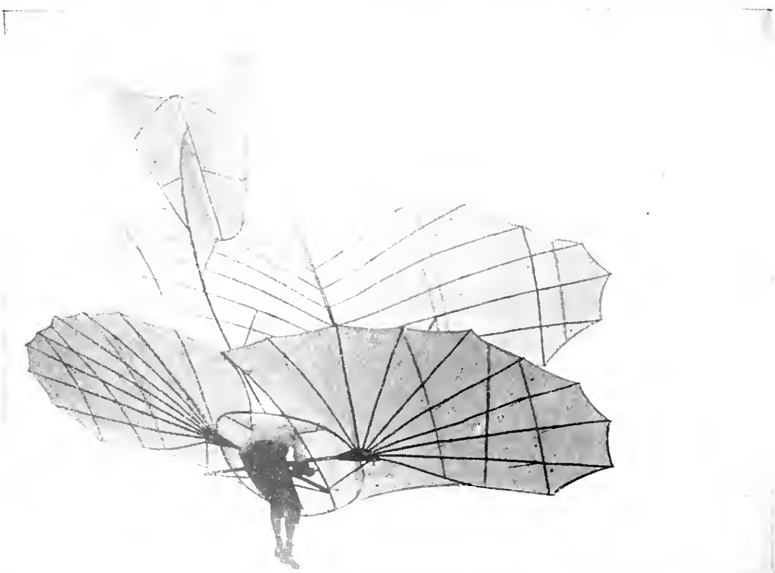


Fig. 8.

Fig. 7. The landing is brought about by raising the apparatus in front somewhat, and by lessening the speed, as shown.

Fig. 8. Shows an exact picture of the construction of the apparatus, as well as its management.

by the birds. We may either experiment with an apparatus driven by a motor, very light in proportion to its energy, and so endeavor to emulate the flapping birds ; or we may try to imitate the soaring birds, who derive from the wind all the power required for flight when once they have gotten well under way.

I deem the latter path beset with fewer difficulties than the other, both because there will be only the apparatus to manage, instead of both the apparatus and the motor, and because the experiments will be much less costly, and the inevitable breakages much easier to repair.

A study of past experiments has led me to conclude that almost all failures hitherto have resulted from lack of adequate equilibrium. There have been other contributory causes, such as inadequate construction or strength, inefficient motors, etc.; but the machines have almost always come to grief for lack of that stable equipoise which the bird maintains by instinct under the varying conditions of flight and wind. There first must be safety under all conditions, in rising, in sailing, and in alighting, and it seems evident that, until this is secured, no great progress can be made towards a mechanical or a commercial success.

The ultimate flying machine will probably be provided with a motor, but it seems also probable that there will be machines for sport or for individual use, depending upon the wind alone, and that the shortest road to initial success is through the development of the latter.

Indeed, there have been before Lilienthal's a number of partial successes which might have led to a solution of the problem, if the varying essential of equilibrium had been adequate. About A. D., 1178, a Saracen (name not given) rose into the air in presence of a large assembly at Constantinople, but he soon lost his equipoise and fell to the ground, receiving severe injuries. Towards the end of the fourteenth century, Dante, a mathematician of Perugia, succeeded in soaring over Lake Trasimene ; but, when he repeated the performance over the public square of Perugia, the left wing gave way, so that he fell and broke his leg. Paul Guidotti, an artist born in 1569, made use of a pair of artificial wings several times with success, sustaining himself for a quarter of a mile in the wind, but ultimately he lost his balance, fell, and broke his leg. In 1863 a Spanish peasant named Orujo was carried one league in fifteen minutes, on a rough aeroplane of his invention ; while in 1867 Captain Le Bris, a French sailor, rose and balanced himself in the wind for a short time, but subsequently met with various mischances, and his means became exhausted before he succeeded in securing adequate equilibrium.

Herr Lilienthal is now far in advance of all these experimenters in the comparative safety of his apparatus, but he says and repeats that the inconstancy of the wind is the chief enemy to overcome, whether a motor be used or not, and that the variations in the speed and direction of air currents are the principal hindrances to equilibrium in the air. And yet the sailing birds prove to us that this enemy can be overcome, that its forces, indeed, can be transformed into an adequate motive power, so that man, in a moderate wind, may learn not only to maintain his balance, but also to translate himself at will without an artificial motor.

The writer therefore suggests to those seeking a solution of the problem of flight that they should turn their thoughts and experiments in the direction of soaring flight, and seek thus to secure equilibrium and safety in the air. In other words, that they should endeavor to learn the science of the sailing birds.

Such progress has now been made, and knowledge gained, that it seems preferable and reasonably safe to experiment, after the first trials, with full-sized machines instead of models ; such machines need not be costly. Of course, proper precautions must be taken to avoid accidents at the beginning, and this may be accomplished by experimenting on a soft sand hill, or over a sheet of water. A steady wind is needful,—say, eight to fifteen miles an hour,—and the operator must acquire an initial speed of his own, either by running, by starting from a vessel under speed, or by rising upon the wind like some birds, and then gliding downward. These conditions make it preferable to select some sub-tropical or trade-wind region, where the wind may be depended upon to blow with the right intensity nearly every day. There the merits of a new conception may be experimentally tested with a full-sized machine and under the constant tuition of the sailing birds, which are, in such regions, almost constantly aloft on outstretched unflapping wings.

The experimenters will doubtless meet with many failures and mishaps. They may break their machines and possibly their limbs, but there seems to be no safer or surer way of ascertaining the exact conditions which will have to be met in practical flight.

Once equilibrium and safety are attained in a wind, it will be time enough, in the writer's judgment, to add an artificial motor to the apparatus. If an aeroplane endowed with automatic equilibrium has first been developed by experimenting in the wind, methods of adapting motors thereto will be speedily discovered, and we shall reach a full solution of this problem of transportation through the air, which has been puzzling man for over two thousand years.

MODERN MACHINE-SHOP ECONOMICS.

By Horace L. Arnold.

I.—THE LOCATION OF THE SHOP.

IN a vast majority of cases the location of our large American machine shops has been determined by accident.

Almost or quite all of our notable establishments have grown from small beginnings, and the history of their rise and progress can be traced back to the employment of a very few men by some mechanic of superior attainments in the line of skill or business foresight, more often the latter than the former; and the shop where the then unknown founder of the great present industry began his long career of success was commonly located near his actual or probable customers, and in the cheapest shelter at all suitable for the requirements of the day ot small things.

The founders of our large machine shops may have hoped for the successes which came to them, but not one case can now be brought to mind in which the originator of any now large, or even considerable, machine shop was in a position to choose his location and surroundings when he first began to employ workmen. The first of the name always began with a few men, in a location not specially desirable to others; sometimes there were one or more removals, as business increased; often there were none; rented premises of small area were purchased and added to, as necessity demanded or profits allowed, so that the large plant of to-day often surrounds the original site where the two or three or half a dozen original employees of the founder of the great works began their labors. Thus the old brown wooden cottage where the elder Roebling lived with and boarded his entire working force when he began drawing wire at Trenton, N. J., now stands in close proximity to the Italian villa which was later the Roebling family mansion, in the midst of the vast buildings which now shelter the thousands of workmen employed by the Roebling's Sons Company. The Italian villa with its still carefully-kept lawn and profusely-blooming banks of roses, has become the business office of the great works; the old brown cottage is a store-house; and Roebling's hands still follow the same streets to their daily toil that encompassed the little handful of wire-drawers who, under the rule of the original Roebling, slept and ate in the weather-beaten structure in the midst of the Roebling buildings of to day. Almost the same story can be told of the Allis-Reynolds shops of Milwaukee, the Globe Iron Works of Cleveland, the Baldwin shops of Philadelphia, the now diminished, but long noteworthy, Novelty Iron Works of New York, the Birmingham Foundry of Birmingham, Conn., the Waterbury Farrel Foundry, the Pratt & Whitney Company of Hartford, and the Builder's Iron Foundry of Providence. Pratt & Whitney began to employ men while they were yet themselves employees of the Phœnix Iron Works, and their half-dozen or dozen hands were moved fron one hired room to another, until Pratt & Whitney finally cut loose from the Phœnix, and took their handful of mechanics to the Flower street bridge over Hog river, where their present shops now reach along both sides of the river, and occupy both sides of Flower street at the bridge.

It may be truly said that the great machine shop is almost never intentionally located ; it stands where its exceptionally-endowed founders first took root in a fertile business soil, and in only a few cases are the situation and buildings very well, or even well, adapted to the requirements of the great business there carried on to-day. The expense of removing a large machine shop is always great ; there are delays in business to think of before removal is decided upon ; and, above all, the enormous labor imposed upon the heads of a prosperous firm, already overburdened with the superintendence of the intricate ramifications of great undertakings, stands in the way of removal from the huge aggregation of old, dark, inconvenient shops to a new establishment planned to facilitate operations and decrease costs to limits not to be attained by rearranging and rebuilding on the old site. Hence it is the rule that large American machine shops are far from well arranged, well lighted, or conveniently located.

In some cases, however, removal is decided upon, and a few months of working double turns, and endurance of countless annoyances and vexations, leads to the ample reward of commodious, well-arranged shops and offices, where both employers and men perform their duties with such ease and pleasure that they look back and wonder how they endured the evils of the old shop for so many years so patiently. Such a case as this is to be found in the new Gates shops, in Elston avenue, Chicago. The old Gates shops had grown up from a very small beginning on the west bank of the south branch of the Chicago river to a great establishment, and had divided once, the offshoot, now the large Fraser & Chalmers shops of world-wide reputation, being located only a few squares away from the site of the original shops, although it has already removed its foundry far out on the prairie, and proposes soon to follow with its great machine tools to the same roomy locality. The Gates shops endured their old quarters until after the death of their founder. Then the young blood fled from ills they knew but too well to one of the most convenient machine shops and foundries in America for the employment of, say, five hundred men.

It will thus be seen that it is rarely, very rarely, the case that any save highly successful concerns can ever be said to really choose a shop location. Small or large, a business must be paying good dividends and must promise continued success, to warrant serious contemplation of removal.

Such removals are commonly made from a crowded locality to one where there is more space; they are sometimes made from the town to the country, and sometimes from the country to the very heart of a great city. It is instructive to briefly note one or two cases of each sort, and to consider the reasons which influenced the removal in each case.

The Garvin small machine tool building shops, then Smith & Garvin, removed from town to the country in New Jersey. After a few years in the country, Garvin came back to Center street not far from the Tombs, in New York, and later removed to Canal and Laight streets. When the firm went into the country, their most valued hands declined to follow them, and very naturally the same refusal of good men to leave the old location for the new one followed the change from country to town again. The cause is obvious; the really valuable workman is the one who forms home ties and local associations; he is in his way independent. He is not a rover, not one of the floating population; he takes root where he stops, and, after a few years of location in one spot, he has individual interests, distinct from shop interests, which make him unwilling to change either a town residence for a country residence, or a country habitation for town life. The worker who is by natural tastes and preferences better suited with the comparative quiet, seclusion, and even isolation of country life has an extreme aversion to the forced contact with the common herd which is the inevitable lot of the wage-earner in the town machine shop; in the same manner the gregariously-inclined workmen will not be contented with country solitudes. High day-pay may tempt them to make the trial, but they are soon wearied by the monotony of green fields and unpaved roads, and the deadly quiet of village evenings; they mope, grow listless first, then restless and impatient, and soon seek those city sights and sounds of close association which alone can satisfy the demands of their natures. The constant tendency of wage-workers to build up vast cities and leave the country a desert waste is ample proof that it is far easier to fill a shop with workmen of any desired grade in town than in the country. It makes little difference what part of a town is chosen for a shop location. There are always facilities for short travel; there are car lines, there are meeting- and lounging-places for the evening; and, above all, there is the liberty of town, that sweet personal liberty never to be enjoyed in villages, which are always supervised and actually governed by a set of squeamish, over-nice, and over-zealous inquisitors, whose sole object in life is to ferret out and submit to public comment the minor failings and indiscretions of the artisan of towny instincts, whose unhappy lot is cast amid green fields and blooming lanes. So Garvin's good town men would not stay in the country, nor would their good village hands take service in Center street. From a shop point of view perhaps the country help is a shade the better. It is a little less tractable, but a little more reliable. The town help adapts itself the easier to new conditions, and is less likely to found obnoxious unwritten laws of precedent which so often make life a burden to the new superintendent of an old country shop. The one great drawback to the village shop is the inelasticity of the labor volume. The shop has a certain working force, which can not be quickly or easily diminished or enlarged. If a foreman in the country has a good man who is willing to stay, the foreman is very willing he should stay. If the foreman succeeds in organizing a good gang, or team for combined effort in a certain direction, he will exercise great forbearance before he breaks it, because he does not know how to fill a vacancy made by the loss of a specialist. In town the case is exactly the reverse. If a man does not exactly suit, he can be retired without remorse, as the employer knows that other employment awaits him, and also knows that he can find a man better adapted to his own requirements. Indeed, so far as help is concerned, there is no question in regard to the merits of town and country.

The Liberty Cycle shops at Rockaway, New Jersey, follow the machine business under truly idyllic conditions. The business demanded increased force for 1896, and the Liberty organized a new department nearly a hundred miles away from home, in Bridgeport, which is full of light metal workers of every degree. In speaking of this step, the manager referred to the difficulty of augmenting the force of Rockaway workers. First of all, the most desirable class of hands would not take temporary employment, even though they chanced to be idle, in Rockaway, where there was no other machine shop. The same men would have eagerly accepted the job, had the shops been located near other shops of the same class, so as to afford at least the chance of making the employment permanent. In the next place, such help as could be obtained in emergencies had to come from town, and invariably, after a short submission to the deathly quiet of country nights, proceeded to organize for itself diversions of a character extremely obnoxious to the sober-minded regular employees. The low, one-storied Rockaway shops, as seen in June with sweet breezes blown across the Jersey hills coming through the open windows that looked out on vistas of summer green, seemed delightful to the casual visitor; to the harassed superintendent who could not find workmen to do his work it was a purgatory, a very fiery furnace of endless vexation and tribulation, and thronging Bridgeport caught the 1896 increase of the Rockaway shops.

The Fraser & Chalmers shops have gone four or five miles out, but four or five miles means little to a town of such distances as Chicago boasts. The new shops are still in town, decidedly. The Edward P. Allis Company Milwaukee shops do not talk of removal, nor do Pratt & Whitney, and both are examples of growth by accretion. They have found room for increased business by extension and building as occasion demanded, one year not foreseeing the needs of the next. The Globe Iron Works of Cleveland are suitably arranged for a great business where large things, like ships, are built, or even large steam engines. It is not possible in a business of this kind to make such perfectly economical arrangements for handling work as can be devised where the heaviest single production weighs only two or three or four tons, and the average weight of finished machines falls below, say, 2,500 or 3,000 pounds.

When, however, a vast business in the manufacture of large structures has grown up in different places, all under one general management, it may be very well and economically made the nucleus of a new small city wholly dependent on this great single industry. The town of Pullman, too well known to need description, is a case in point. Here is a great manufacture made to found a civic economy of its own; whether this city of Pullman, beautiful to the eye, is perfect from a humanitarian point of view is not the question here. It is an undoubted success from a manufacturing standpoint. Westinghouse is just now taking his great works to new shops in a more roomy locality ; and, in brief, any establishment with over a thousand workers can make its own town without much trouble, as it calls for a population of at least 3,000 souls resident wherever the shop is located. It is more with the shop of moderate size that a careful selection of location is a matter of great consequence to its profitable operation.

If a small plant using, say, under a hundred operatives is considered, it is easy to see that location may make the difference between success and failure. To begin with, such a concern must have its own line of special work for the general market before it can choose its location. If it depends on general work, it must be so located as to meet the convenience of its patrons ; this is the first requisite, and cannot be ignored. But, in case the shop has the country at large for a consumer of its output, then two things are essential for its survival. First : excellence of product. The quality of the output must be fully up to the requirements of the user. No matter how perfect the foresight of the designer, or how eager the user is to purchase, or how certain the monopoly secured by the protecting patent,—if the quality of the work is not fully up to the requirements of the user, the enterprise must languish. The second requirement is none the less imperative, and is that of very cheap production, to enable such an accretion of profits to be stored as will enable the original manufacturer to compete with imitators and rivals, who, taught by his experience, are sure to spring up as soon as he becomes known.

Such a manufacturer must choose his location and his buildings and plant carefully. He must be able to secure suitable workmen at a fair price, and to place them in healthful surroundings. He must have good and competing lines of transportation. He must not have a fixed charge, for heavy trucking, between the shop and the railway or waterway, of one or even two per cent. of his sales, as is often the case. All of these conditions point to the town of at least 10,000 inhabitants as the smallest that can entice the prudent operator of a manufacturing machine shop; and even then he must be able to make his own help largely from unskilled labor by the minute subdivision of his processes. He must have a healthy and agreeable location for his workmen, who must be induced to remain with him so long as he desires, if he would secure the best results. He must have good shops, with good light, good ventilation, good sanitary devices, and in many lines of work he must provide comfortable and decent, or even refined, surroundings for women workers. It would have sounded very strange indeed to speak of women as factors in machine production ten years ago in America. We read with something like horror a few years since of the miserable lives of the English women and girl nail-makers of the first part of this century. To-day there is a constant and rapidly-increasing employment of women in the bicycle shops, and in the Hartford screw shops there may be seen lines of women and men indiscriminately mixed as operatives of the heavy hand machines. Waterbury shops are full of women who make their living in different branches of metal work; in Weston's electrical instrument factory in Newark a great many young women, among the best dressed and most intelligent in appearance of any shop-workers ever seen by the writer, can be found. Some of the cycle shops use a considerable number of women metal workers, and there is no doubt that, in the vast present increase in the demand for the "skilled laborer" class of machine-tool operators, women will be employed side by side with men, on effective automatic or semi-automatic tools, in largely-increasing numbers. In speaking of the exceptionally fine appearance of his women metal workers, Weston said he could not get good work from inferior women, and that a lack of neatness and taste in dress and those qualities which are commonly held merely feminine, marked an organization not suitable to do the work on his delicately-constructed electrical measuring instruments. And what Weston said of women workers is also true of men workers capable of achieving the most economical production. They must be possessors of a certain degree of intelligence and refinement; bright, alert, intelligent boys and intelligent and self-respecting young women are soon to come largely into prominence in the performance of work which was but lately thought producible only by the hands of thoroughly-skilled workmen. The semi-automatic tools are changing this, and the line between the tool operator and the tool maker is becoming every day more markedly distinct. For light machine construction the owner must so locate and arrange his shops as to use women as well as men, and he must provide for the health, comfort, and self respect of his workers.

Of the wholly-isolated machine shop there are very few examples. There are one or two isolated foundries, special to the last degree of specialization, where work is made in perfection at incredibly low prices; but isolated machine shops are too rare to be taken into account. There are several isolated manufactories of large extent in the United States, which form a most interesting class study, and there are some machine shops which have gained the advantageous effects of isolation by inventing and practising special methods of dealing with workmen which distinctly separate these establishments from others of equal rank without a sacrifice of the advantages of town location.

Day wages for machinists are at this moment perhaps lowest in Fitchburg and Worcester, Mass., and highest in Toledo, Ohio: and the labor cost is in all cases the item to be attacked in the battle for low-cost machine production. Yet it does not in any way follow that the local day wage for machinists, high or low, should influence the location of a machine shop. The first requirement for low labor cost production is a healthy, contented worker, capable of continued efficient exertion, and not only willing, but eager, to give his utmost effort to advance the designs of the employer. Obviously, this condition of the worker cannot be gained by forcing wages to the lowest possible point. Great successes have clearly proved the propriety, and, it may be safely said, the necessity, of paying high wages to workers, if the greatest reduction of labor cost is to be obtained. Some system must be devised and followed which will make the unit of production the wage-producing factor, regardless of the unit of time. It is highly probable that all seeming contradictions in the machine-shop methods known to produce low labor cost work would disappear under correct analysis, and that somewhere in the productive system of the economical establishment there is always to be found a dominating factor of very highly paid labor. This factor may not affect the actual worker's pay, but it must be so placed as to directly affect the worker's output. In view of present examples, it does not seem that the locally prevailing day-wage for machinists should have any weight in the selection of a machine-shop location.

Transportation costs of raw material and finished product are in all cases fixed charges, incapable of much reduction, and are items worthy of careful consideration in connection with shop location. The industrial meridian of the United States probably does not lie east of Cleveland, and there are considerations which would, perhaps, induce a prudent machine manufacturer to decline a location very much south of Pittsburg or Cincinnati. The vast recent growths of machine-shop manufacturing in the area bounded by straight lines drawn between Pittsburg, Cleveland, Chicago, and Cincinnati, indicate clearly the great natural advantages of this district for finished metal manufactures.

The establishment of the works of the General Electric Company at Schenectady is an example of location influenced by proximity to New York and to a local iron-producing territory. The Westinghouse Electric Co. is just now taking commodious quarters near its original Allegheny location, while the Siemens-Halske takes a suburban site left vacant by the demise of the Grant locomotive works, on the prairie seven miles west of Chicago court-house.

So far the supposed vast advantage of power supplied from Niagara Falls does not cut any figure at all as a dominating factor of shop location. It is even denied that at near-by Buffalo Niagara Falls motive power can be furnished more cheaply than steam power, and machine-shop motive power is, in a vast majority of cases, a very small cost item in the grand total of production outlay.

A more extended consideration of the subject will, it is believed, fully warrant the conclusion that the character of the workers obtainable, the health and comfort of the workers, and the fixed charges of transportation of both raw material and finished product, should be the considerations deciding the location of a machine shop intending removal from its present location.

PURE WATER FOR DRINKING AND COOKING.

By S. P. Axtell.

OUR municipalities are called upon to solve no more difficult and important question than that of procuring a pure and satisfactory water-supply, by which is here meant a wholesome potable water, free from objectionable or injurious constituents, whether of mineral or organic origin.

Distillation gives us the purest water that can be obtained, but it is neither palatable or best adapted to the wants of the human system. It does not contain the mineral salts and substances necessary to give tone, strength, and development to our organisms.

Observation and experience cause me to regard all surface waters as more or less contaminated, and liable at any time to become dangerously so. They are waters that have flushed and purified our water-sheds, streets, gutters, and sewers, the latter containing the drainage from dwellings, factories, jails, and hospitals. Thus it takes up human and animal secretions and excreta, and this disgusting mass of filth, containing millions of germs of disease and death, is usually drained into the river from which the water-supply for great communities is obtained.

Ground water passing through a foul soil also is poisoned and rendered unfit for general use, though, as a general rule, it will be found pure, and any community which can obtain an abundant supply of such water should consider itself fortunate. But it is usually found to be a limited and frequently failing supply, and this fact precludes dependence upon such sources of supply for large towns and cities. They are, therefore, compelled to obtain a surface supply, notwithstanding all the dangerous possibilities of its contamination. Nor is the outlook for the future encouraging. Year after year, as the country becomes more densely populated, the contaminated condition of our streams and water-sheds will grow worse, rendering it absolutely necessary that some form of relief be obtained.

At one time it was thought that filtration might prove the solution of our difficulties, but on a large scale it is found to be impracticable. How could New York filter and purify about two hundred million gallons of water per day? The expense incurred in the erection of such a filtering plant would be enormous, and its protection, constant repair, and operation would be onerous. And then at best, on so large a scale of operation, we would have only a strained water, the filters removing only the matters held in suspension, leaving the poisonous principles still to a large extent present for the propagation of disease. And, should an attempt be made to purify so immense a body of water by chemical action, it would certainly prove a herculean task. But why this necessity? Pure water is not required for putting out fires, for flushing water-closets, streets, and sewers, or for mechanical and many other purposes. Absolute purity is required only for such water as enters the stomach of mankind.

I do not wish to be understood in the foregoing as opposing filtration; on the contrary, I believe it should be universally used, and in such practical and efficient manner as to obtain the best results. While none of our largest cities have been willing to engage in the task of purifying and filtering their immense water-supplies, all will agree that it is perfectly practicable to purify water in small quantities. Neither do I wish to be understood as claiming that it is impossible to succeed moderately well in filtering and purifying hundreds of millions of gallons of water daily.

But, in the attempt to manipulate such immense quantities, aside from the enormous expense and trouble, there would be much more liability to imperfection and inefficiency than in manipulating smaller amounts; so that the practical business solution of this matter comes to us in the homely expression: "Would you use a hand-spike to kill a mosquito?" Or filter and purify a million gallons of water to get a drink?

After giving much thought to this subject, I have been led to the conclusion that there is but one practical remedy for this great and growing evil,—namely, the adoption of a dual water-supply system.

The question naturally arises: What quantity of pure water would be required for such a service? This can be answered only by an estimate, as no data exist upon which to found an opinion. It is believed, however, that the amount can be very closely approximated, and that a daily supply of two gallons per capita would, under proper regulations, be a sufficient quantity for culinary and drinking purposes. If this estimate is not far out of the way, New York, the Empire City, would be supplied daily for the above service with less than four million gallons of water, finely filtered and made chemically pure, bright, and sparkling.

For our future water-supplies we therefore propose: (1) to use the present system for the main supply; (2) to construct a new and pure water-supply system distinct from the main plant. The miles of pipe required would at least equal those of the main plant; but, their capacity and that of the pumping plant and reservoirs being small and the system not requiring fire hydrants or many expensive special castings, the cost of construction would be comparatively light. This plant can be built either upon the reservoir, direct-pumping, or gravity system. The first duty would be to obtain the purest water-supply possible. Such can frequently be procured from a ground or spring-water source, but in all cases it should be given a thorough analytical test for impurities, and, if any are found, they should be removed by such chemical or electrical action as may be required. In every case its purification should be completed with a deep and thorough filtration. If the plant is to be built upon the elevated-reservoir plan, the water thus purified should be discharged from the filters into a clean covered well, at the small pumping station, and from there pumped up into a series of small connected reservoirs, constructed of such shapes and dimensions as would render it entirely practical to erect permanent buildings over the same, to protect the water from the scorching rays of a midsummer sun, as well as from dust and all pollutions which open reservoirs receive from animal and vegetable matter. Proper help should be employed to keep these reservoirs and buildings as clean and pure as an old-fashioned spring house. It is an old truism that "whatever is worth doing is worth doing well." In advocating a revolution in our water-supply service, I may recommend some features which at first may appear to many chimerical and unnecessary. Of course, they can be adopted or not, just as parties interested desire, but I believe the day has come when mankind should pay more attention to what they eat and drink, and therefore I recommend that, in connection with these reservoir buildings, a small refrigerating plant be erected, and so much of the pure water be frozen or refrigerated as may be necessary to keep the water in storage in a cool and palatable condition. The distributing and service pipes that conduct this water through the city to the consumer are usually placed at a sufficient depth in the ground to prevent any changes in temperature from materially affecting them, and, if the little service pipes, upon entering the building, were covered with some non-conductive material, it would keep the water cool in the summer, and prevent freezing and bursting of pipes in the winter.

If the system used is to be direct pumping, all constructions of the plant and all operations connected therewith would be the same, with the exception that the reservoirs would then be built in connection, and on a level, with the pumping station, and the water would be delivered from the engines directly to the consumer in the same pure and palatable condition. As the city will receive a good revenue from this pure water system, it can afford to be liberal in its construction and care ; therefore, to obtain the desired sanitary result, it is recommended that the city, at its own expense, tap the pipes of this service, and run the water into every building requiring the same.

This being done as a sanitary measure, it is believed that no very formidable ordinances would be required to cause it to be universally used.

As our pure water-supply would be limited, it would be necessary to protect it from illegitimate use and from waste. This could be done by placing a very small, but accurate, meter upon every service pipe that enters a building, and charging a rate per thousand gallons that would preclude waste or illegal use.

For illustration, I propose a tariff of one dollar per thousand gallons. This, while it would give a revenue of one thousand dollars per day to the city for every million gallons used in the aggregate, would not prove onerous, for, if two gallons per capita per day should prove a liberal supply, a family of five persons could use daily ten gallons of cold, pure water at a cost of one cent,—a price that would be cheerfully paid, as they could not for that amount buy enough ice to cool two or three gallons of the dirty pond water they usually receive.

It would perhaps be well to charge or set a minimum rate upon these meters, as some, through avarice, might be inclined to use the foul water from the main plant, and thus engender disease in their midst.

I am aware that the benefits derived from this health-giving and luxurious supply would be far-reaching, not to be measured by dollars and cents.

It will be found, however, that, even from a pecuniary point of view, comparison with all other schemes results in its favor.

The cost of such a plant would vary to some extent. A competent engineer can very closely approximate the expense of such construction, when he knows the number of miles of pipe needed, the number of taps required, and the facilities for obtaining a good water-supply, in the particular vicinity. The larger portion of the system may be constructed with pipe varying in diameter from three to six inches, and a quarter-inch meter would be large enough for the service.

It is a common practice with engineers to estimate the cost of railroad and water-works constructions by the mile, when they wish to give a general or approximate cost of such a plant. I may estimate the cost of our construction at $15,000 per mile,—a figure probably much too high. It is reported that Philadelphia is contemplating the expenditure of eighteen or twenty million dollars to obtain a better water. Estimating that she has about 650 miles of water mains, and would need as much for a pure supply, the system, on this basis, would cost $9,750,000,—a saving in the cost of construction of about $9,250,000; moreover, the water obtained would be much more pure and palatable than any surface water.

Nor is this all ; should Philadelphia obtain the distant supply at the estimated cost, she will have depleted her treasury to that extent.

Should she, however, adopt the dual supply, and charge for the pure water as she would be compelled to do to protect it from illegal use and waste, she would get from this source an annual income of over $750,000 ; and the amount would be cheerfully paid by the consumers, as they would get more than value received in the quality of the water.

There is one other fact that should be considered. The expensive foreign surface supply may in a few years become contaminated from causes not now existing or anticipated ; then another source of supply would become imperatively necessary, costing as much as, or perhaps more than, the one now contemplated, and with no greater security for the future. But the dual and pure water system would settle the question of her water-supply for generations to come. Philadelphia has plenty of water in her rivers for the main supply, good enough for all such purposes, and, should she need a million or two more gallons per day for the pure supply, it could easily be obtained at small cost.

New York is expending millions in the construction of conduits and impounding and storage reservoirs, in buying lands, and in fighting the inhabitants of the Croton water-shed. Why not use the dual supply system ? If the Croton water-shed becomes contaminated (as it already is), the water will still put out fires, and, if it fails to give a sufficient supply for the main purposes, a pipe could be run up the Hudson river above tide water, through which all the water needed could be pumped.

Brooklyn is differently situated from most cities in being entirely surrounded by salt water, but all she has to do is to procure her pure water-supply, and at the same time, if she cannot pump water enough out of the ponds and sands on Long Island for the main supply, run a pipe to the Hudson, where there is enough for all.

Cincinnati has been anxious for years to expend about six millions of dollars for a new surface water-supply. She has probably about 250 miles of pipe, and a dual supply would cost her about $3,750,000, leaving a saving of over $2,000,000. She has plenty of water in the Ohio river for her main supply.

Boston, Washington, Baltimore, Pittsburg, St. Louis, Newark, Jersey City, and, in fact, every city in this western continent of any importance, needs a purer and better supply, and could secure by this system corresponding savings and benefits.

I am aware that the adoption of this plan would make a radical change in our system of water-supply, but where grave and dangerous errors exist radical remedies are required.

On hydraulic engineering we depend for protection of health, life, and property, rendering it a work of vital importance. We are compelled, however, to admit that, in the hydraulic engineering of to-day, we are pursuing exactly the same plans, principles, and methods, for our water-supply, that our grandfathers pursued a century ago. There is this difference in favor of the grandfathers' work. Then the country was sparsely settled, and our water-sheds and streams were comparatively pure, while now they are polluted, and our rivers are but the open or drainage sewers of the country.

This condition has continued for many decades. Boards of health have condemned the waters as unfit for use; the press has proclaimed their vileness; physicians have warned us against their use; and our mothers, wives, and daughters have made personal appeals to the powers that be to give us, in place of the present vile pollutions, a good, healthful, bright, and sparkling water. But all to no purpose. We seem to-day no nearer the attainment of the desired blessing than we were fifty years ago.

The question naturally arises in our minds: what is the cause of this neglect, or this want of intelligent action and progress, in a matter of so much importance?

The charters of our municipal corporations are lame in some respects. A favorite charter of the present time is one in which the people elect the mayor and financial officers of the corporation, who are held responsible to them for the faithful performance of their duties. The mayor, in the fulfilment of his obligations, appoints a chief engineer for the department of public works. This appointment is made from a class of men known as civil engineers, and on the appointee devolves the duty of making plans and specifications for all construction required by the city and of giving due superintendence to the same. He is supposed to be capable of filling the positions of civil, sanitary, railway, mechanical, architectural, electric, and hydraulic engineer. The duties and requirements of each of these branches of engineering are so separate and distinct that the man had better undertake the task of successfully practising the professions of medicine and law during the week, and engage to deliver an able theological discourse on Sunday. Time and experience have demonstrated that thought given to a special subject in science or art tends to progress and perfection. It is the concentration of thought or forces that produces results.

Let our municipalities, therefore, secure and follow the advice of disinterested experts who have become distinguished in that branch of municipal engineering in which progress or reform is desired.

The hydraulic engineer should be a man educated in his profession, capable of constructing an efficient fire protection system, which, by the way, is seldom found in our cities. How often do we hear of millions of dollars being lost for want of a proper water-supply! There was enough water in the reservoirs, but, from small pipe or defective construction, it could not be obtained when wanted. The hydraulic engineer should understand thoroughly the conditions and affinities of water, and especially should know what kind of water will benefit the human constitution.

Political parties originate in differences of opinion among men upon the true policy of the government in regard to tariff rates, banking, currency, and many other questions of a purely national character. They are commendable on the ground that they produce discussion of the principles of government. But, when such parties set up their lines in purely local elections, and assume, by virtue of their organized strength, to control the management of our municipal corporations, upon the principle that "to the victors belong the spoils," such politics becomes the bane of our social and municipal organization. The practical interpretation of this doctrine is that the ward heelers, the saloon keepers, and the political hustlers are the men who influence, and often dictate, the appointment of officers whose duties are vitally important to the health, happiness, and safety of the whole people. Who does not know of the existence of just such conditions? And who can fail to see that the system involves an enormous waste of public money, and stands as a positive bar to progress and future welfare.

Municipalities are always slow in making radical changes in their methods of conducting the public business, and it may be many years before they move in this vitally important matter. But I firmly believe that the plan here suggested, or something similar to it, must in the near future be adopted as the only remedy for our present defective and dangerous methods of procuring water-supplies.

ARCHITECTURE OF MODERN BANK BUILDINGS.

By R. W. Gibson.

II.

AFTER the study of the question of business facilities,—the reception of customers and the execution of the resultant work, as treated in my former paper,—comes the important demand for security. The preliminary arrangements of the floor, which, of course, are the prime factors in such an architectural problem as a bank building, will have been made with some attention to the placing of safes and vaults and entrances so as to prevent robbery and centralize responsibility in definite places. The cash-safe, or vault, will be placed so that the chief teller may supervise it, or, better still, the door will be arranged actually within his caged compartment. The security vault, if in the basement (as is most desirable), will be reached by a stair and elevator convenient to the officers' department, or else will be isolated in the basement by grilles allowing of continual inspection and yet preventing access. The greatest ability in planning is invited in the arrangement of easy communications with perfect security, and it must be admitted that the greatest defects occur in this particular field, even in recent buildings. The stair or passage solely for the use of clerks may very properly pass close to a basement vault-door,—it is a safeguard,—but a passage used by caterers or strangers or engineers or ashmen has no business there. Yet the most secluded vault is not the safest one. Accessibility for proper persons is to be desired, but only by special routes used for restricted purposes. These data lead to the general rule that the security vault should be placed nearly under the officers' rooms; and, as there may be occasion to use it for specie reserves (it is wise to do so, if ground-floor space is limited), a small lift is valuable, and its position may be toward that side which will favor access from the tellers' departments.

The book-vaults may be reached by the same lift, provided it is arranged at the bottom so as to open upon a hall between the security-vault and the book-vault. Many books may, however, in a fireproof building, be safely taken care of in their own departments in metallic storage cases. There has been recently much improvement in these useful contrivances. When well constructed of sufficiently heavy metal, they really stand intermediate between the fireproof safe and the antique tin box. They will resist any fire likely to occur in a fireproof building properly furnished, and they help themselves in this direction by supplanting great quantities of woodwork in furniture. For special cases they can be made with a fireproof filling of asbestos, which increases the resistance.

The growing dissatisfaction with the practical results of fireproof construction is entirely due to lax and inconsistent practice. The quantity of woodwork usually tolerated in a so-called fireproof bank is absurd and unnecessary, to say nothing of carelessness in regard to well-known structural rules. In the really conscientious work of experienced designers these matters are rapidly being advanced. After wooden-framed walls had been rejected, came the dismissal of wooden-framed floors; now the attack is upon cabinet work and furniture. The partitions of oak paneling must go; bronze and marble are equally handsome, and do not burn. So with the wainscotings and window-jambs, the counter-screen, and the clerk's desk with cupboards and drawers underneath and perhaps a waste-paper basket as an ingenious time fuse; what better combination could be devised than this desk for the encouragement of accidental fire and the making of a quick hot blaze. An enclosed desk is almost as good as the election-day barrel. Even the counter structure is being reformed. The top must be wood,—at least for a while, until prejudices change,—but all that underneath work is condemned. The counter-top and desk-tops can rest upon open legs, or, when storage is needed, upon pedestals of metallic case work, with all the drawers and cases of steel. The counter-screen is to be built of marble, brass, and glass, as has been for some time established. All partitions and cages are to be of metal, all railings of metal or marble. Now, what is there to burn? Some of the floors are wood,—it seems necessary to allow this,—and some of the doors (very few in number) and the tops of the desks. A fire in such a place, kindled anywhere, could burn only the thing it commenced with, even if no one appeared to turn on it the handy and always-charged hose, which is the final argument and which should certainly be in readiness. So furnished, and with thorough construction, a modern bank is absolutely fireproof. The keeping out of a neighboring fire is a question simply of a good external wall. But it must be confessed that this thoroughness is very rare. It is scarcely to be called modern yet; it is the coming rule,—coming because of the repeated failures of a half-hearted handling of the fireproofing question.

Now a word as to details of vaults and safes. Let us look into the interesting devices for security against robbery. First, of course, among these is the safe, or vault, the latter name being applied somewhat indiscriminately to any large safe-keeping structure, although it properly means an arched roof and originally implied a grand and soaring enclosure, instead of a cellar or cell. But, be it a safe, movable and of moderate size, or a vault, larger and built where it is to stand, this chief depository of valuables is to-day a steel structure of great complexity. Its powers of resistance are developed in two directions, —against fire and against robbery. These are quite different kinds of resistance. Fireproofing in the comparatively small dimensions of a vault is simple. Simplicity is its strongest quality. Nothing better can be built to resist fire than a massive arch-roofed cell of brick and nothing but brick, with double or treble walls and double or treble doors of iron so constructed as to avoid destructive warping. But against expert burglars or rioters this has small resisting power. They are defeated by entirely different materials. It is interesting to trace the modern triumph of safe-building over robbery, step by step meeting and nullifying each method of theft. The chief implements of the expert thieves who dared in the good old days to attack bank-safes were the wedge, the drill, and the explosive. The wedge, the oldest and simplest, was a dreaded assailant, and with its first cousin, the lever wedge "jimmy," could do marvelous things. These were met by an improved outside surface, showing no joints or projections which the tool could commence upon. Then the drill had its day, until it was resisted by peculiarly alloyed steel, hardened to a greater degree than the hardest tools. The explosive, used in small and repeated charges, which was the latest device of the "crooks," is guarded against by massive construction and by closest possible joints both in putting walls together and in the fitting of doors and their mechanism. Several methods of construction have been invented to meet

Vault Construction

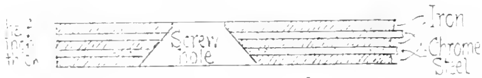


Fig 6 Compound Plate ½ inch thick welded and rolled and tempered

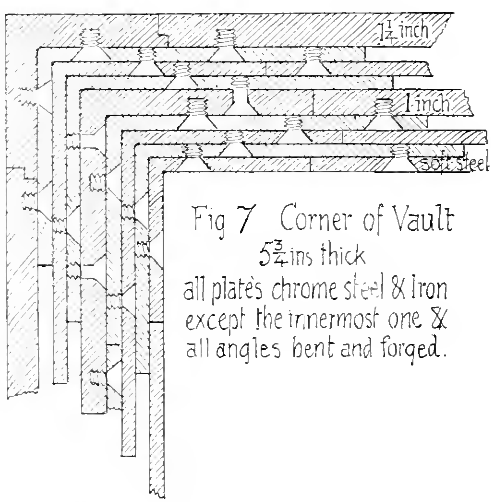


Fig 7 Corner of Vault 5¾ ins thick all plates chrome steel & Iron except the innermost one & all angles bent and forged.

these many requirements, and each doubtless has its peculiar merits. The well-known strength of the spheroid form against external force, as exemplified in the familiar egg-shell, has been adapted to this purpose. It is doubtless superior to any others against such attack as the use of external explosives in mass, or against such accident as falling with a burning building, but its circular work is impracticable for the large sizes of modern vaults, and involves large space in proportion to capa-

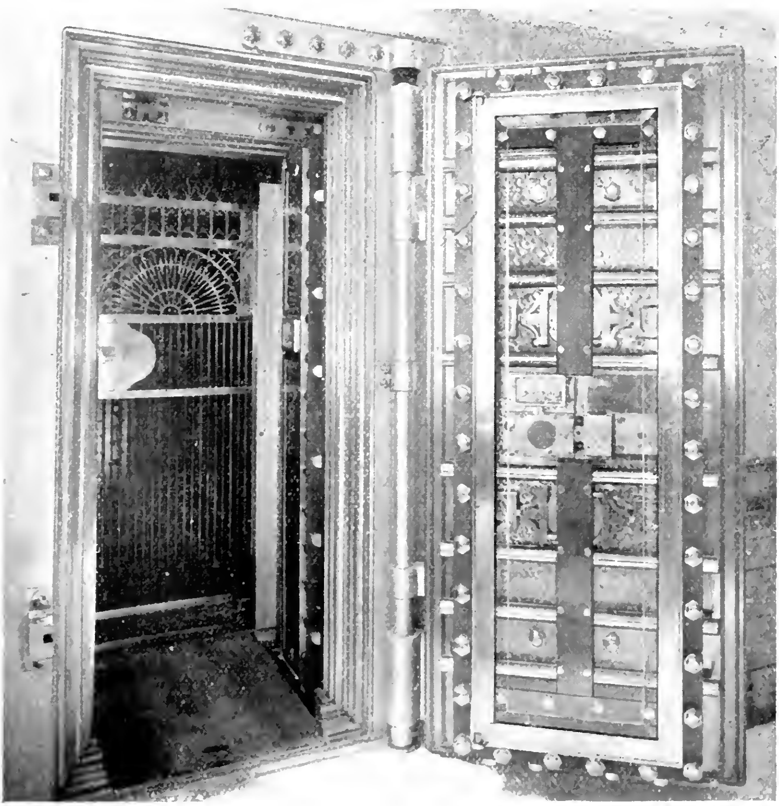


FIG. 8. A MODERN VAULT DOOR.

city. Rectangular construction affords facility for building to any size, and, as against its lesser resistance to massed force, permits of greater thickness of wall to produce the required effect. A system of solid single casting in hard drill-proof alloy is, of course, limited to safes comparatively small. Another, of building in large blocks tongued and bolted and dovetailed together, is more applicable to greater structures. But the device which in practice has been most extensively used, and which may, therefore, be assumed to have been found most reliable in the opinion of the bankers, is the composite steel plate built up in layers to any required thickness. Each plate (from a half-inch to one and a quarter inches in thickness) is composed of five layers, three of tough iron (contributing strength) alternating with two of chrome steel, furnishing hard brittle drill-proof layers in the substance (Fig. 6). These are welded together and rolled to even thickness, then fitted and flattened, and finally tempered. They are then built up in the walls, bottom, and top, of the vault, or

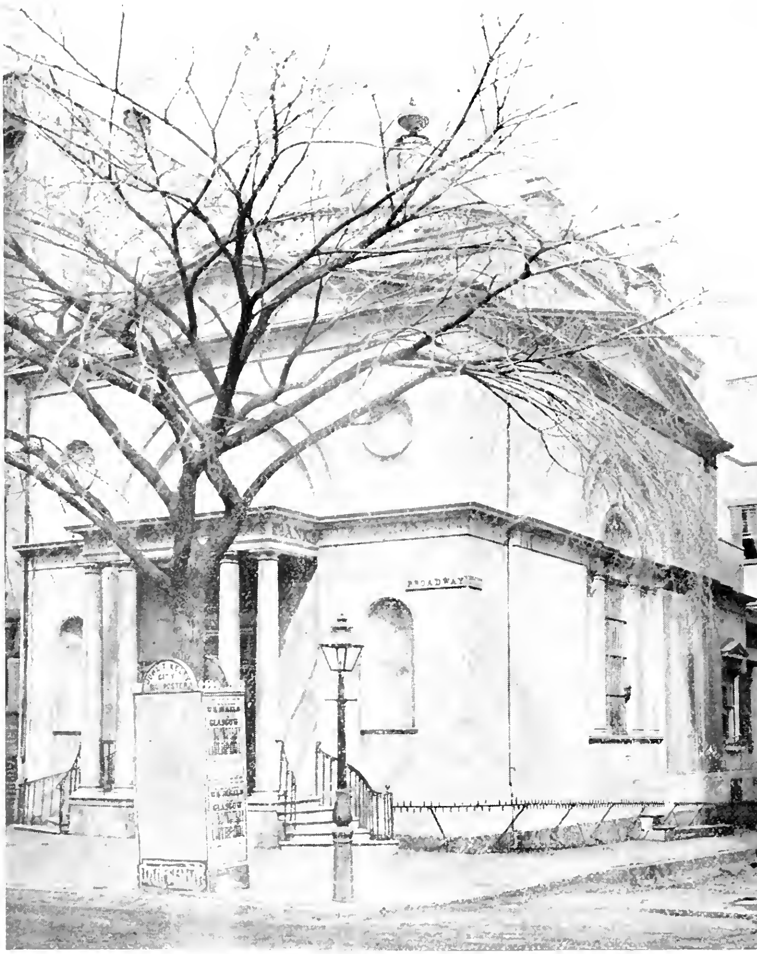


FIG. 9. THE OLD MECHANICS' AND FARMERS' BANK, ALBANY, N. Y.

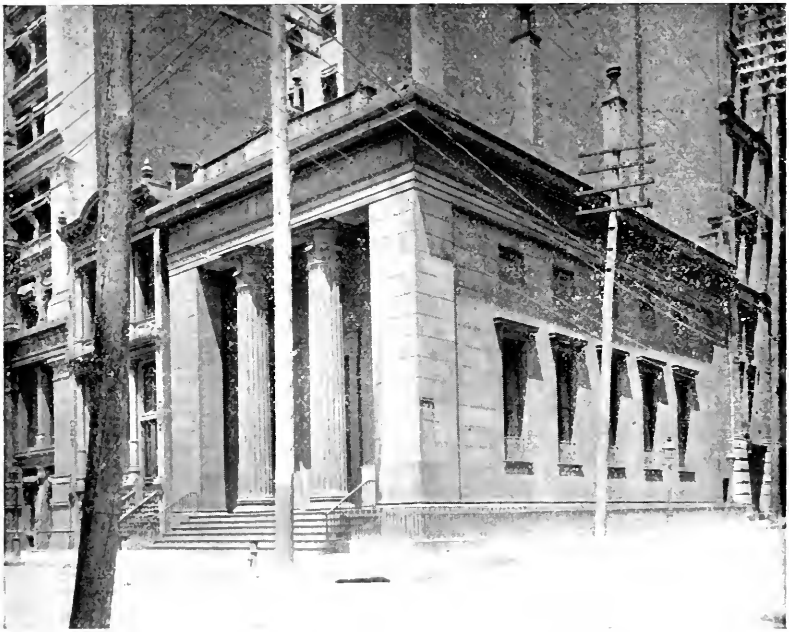


FIG. 10. BANK OF AMERICA, NEW YORK.

safe, by commencing with the outer layer and screwing the next on it, from the inside, with bolts of similar compound material which do not go through to the surface. Each successive layer covers the heads of the screws of the last, and of course each breaks joints. An ordinary good vault has perhaps three inches of such construction, an exceptional one four or five inches. The vaults of the New York Clearing House, the heaviest yet built, have six and a quarter inches. The attack upon the older forms of this work was usually at the angles where the edges of all the plates met, where an explosive might open a joint slightly, and the wedge and jimmy gain an entrance to pry off plate after plate. But such assault is rendered impossible in modern work by making the outer and inner angles forged and bent, removing the assailable joint. Fig. 7 illustrates this construction as applied in the best work, with all the plates bent at the angles and all the corners forged in box-form of three angles meeting.

The next important attack frustrated was the drill. Any ordinary metal can be drilled with quietness and comparative ease, and with not very cumbersome tools. But chrome steel, sandwiched in the substance of the wall, in from six to twelve different layers, defies the hardest tools. Although the temper may be drawn to make the steel drillable by the oxyhydrogen blowpipe, this is hardly a sufficiently portable contrivance to be considered available for burglary. Against the blowpipe thickness of wall is good protection: as soon as the drill has worked a hole of moderate depth, it becomes almost impossible to maintain the draft of the flame in the narrow limits, and its power is gone. The door is usually made in the same manner as the wall, but somewhat thicker, because a small hole in the door in the right place may give access to the mechanism of the lock and allow an opportunity to throw the bolts, which are carried on a separate frame on its inner surface. An illustration of a good modern vault-door is given in Fig. 8. The door being sufficiently thick to defy front assault, the burglar used to attack it in flank. He endeavored, by the use of explosives, to start the plates at a corner, just as in an old-fashioned safe he attacked the walls, using the wedge to enlarge the crack and peel off the plates. This is the point emphasized by the makers of round doors; it is scarcely a weak point, yet the writer suggests that it might be well in rectangular doors to cut off the corners to octagon form with an angle gusset piece of about eight inches, so that the dog's-ear piece, the weakest spot, might be obviated, and yet the useful shape of a natural door be retained. But time is too short for a robber to get in, even by a square angled door of a modern vault. It is a hopeless task. He will perhaps try to smash a spindle which occupies some hole in the make-up of the door; there are, of course, holes where the combination spindle, or where the lever which throws the bolt, passes through. If one of these can be driven in or out by an explosive, he may pick the lock. But now this, too, is guarded against, by using cone-shaped spindles with flanges. It is undoubtedly a fact that a modern vault is unassailable by any method available to a burglar in the limited time at his disposal. Where extraordinary strength is wanted, as, for instance, in a national treasury, or in a place where an armed mob or invading force might have to be held at bay, it would seem that the laminated construction might be combined advantageously with a greater mass of elastic steel forming a core eight inches in thickness, with drill-proof layers of three inches more inside and out, which would give a greater resistance, resembling that of armor plate, to massed explosive force. In vault work there are other recent inventions, description of which space does not permit, such as the time-locks which can be opened only at certain predetermined hours, and automatic time-locks which from within unlock the door at the required hour without the aid of a spindle, and so avoid the hole through the door which it requires. Then there are movable platforms which cover the necessary raised sill of the door so as to afford a level entrance,—

FIG. 11 THE NEW YORK CLEARING HOUSE

a great convenience in a busy bank or safe deposit company,—and the net-work of electric wires which, enclosing every inch of the vault, rings an alarm in some outer place, in case any perforation is made in the enclosing skin.

Next on our assumed schedule of a bank's purposes in a modern building we mentioned reputation and prestige. To these architecture contributes in the highest degree.

FIG. 12. OFFICERS' DEPARTMENT, NEW YORK CLEARING HOUSE.

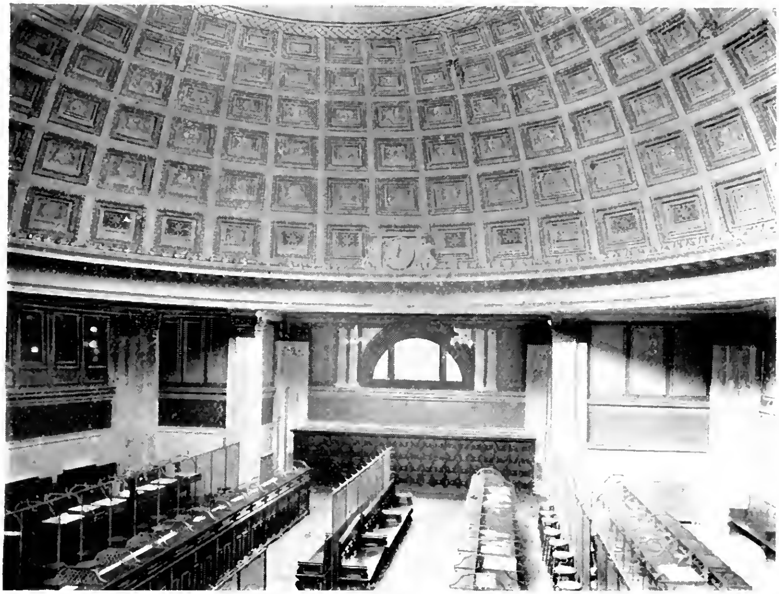


FIG. 13. EXCHANGE ROOM, NEW YORK CLEARING HOUSE.

One of the characteristics of good architecture is that the edifice should announce its purpose. This does not mean that it should advertise itself in clamorous fashion, but in the old language of art—that language in which are written not proclamations, but sermons, in stones—it should unassumingly tell its story. A church should, by its artistic expression, be evidently a church, whether Gothic or Classic or Modern; and similarly a bank should be recognizable as a bank, if it is to attain to the rank of good architecture as well as good building. It scarcely reaches the dignity of which it is worthy if it merely goes as far as to indicate a business building which, while clearly not a residence or a temple, might be a nest of law-offices or a warehouse. It is in this direction that architecture is to be urged as worthy of more recognition at the hands of financial corporations. To the bank reputation and prestige are of vital importance. An institution which exists to extend its own well-known credit for the protection of its customers' less-known credit (a good definition of banking) benefits not only by actual strength, but also by the appearance of strength. Reputation depends not only upon simple solvency and ability, but also upon the outward expression and understanding of these real qualities.

How, then, should a bank be architecturally recognized? What type of building is characteristic of its peculiar virtues? It must be

FIG. 14. GREENWICH SAVINGS BANK, NEW YORK.

confessed that the answer is not readily given ; the question is one long neglected, and only vaguely understood. Yet it has been, and will be, more prominent. In the earlier days of American banking there arose in the older cities buildings which housed the more notable institutions, which were unmistakably banks and dignified examples of good art. The old Mechanics' and Farmers' Bank, of Albany, shown in Fig. 9, is a good representative of the class. It disappeared nearly twenty years ago ; the bank built a new house, larger and more convenient, and the old one made way for a new post-office. There were then a good many of these admirable buildings. The Old Bank of America (Fig. 10) is another example. It was built in 1835, a year when several similar structures arose in the chief cities. It gave way to a large office-building about five years ago. These bank-buildings have nearly all gone. But why has the type been abandoned in their successors? Their art contributed to and expressed the prestige of the bank at a time when each business venture stood more alone and self contained than now. The modern office-building was the element which disturbed these conditions. When these giants of commercial enterprise began their successful career, there gathered upon their pioneer examples a greater prestige than seemed to pertain to any less prominent structures, and a bank which housed a whole village of enterprise gathered fame in doing it. But big office-buildings in many cities have ceased to be distinctive, and the bank no longer earns prestige therein. And in some places where much competition in office-renting prevails and modern buildings are numerous it has become a somewhat less tempting enterprise financially. So that we naturally see now a tendency to return to the older precedent. It is true that circumstances may often demand the office-building, and that, properly treated, it may be artistically as true and good as the other class, although never of such marked character.

The value to a bank of a location where land is valued upon a

FIG. 15. INTERIOR OF GREENWICH SAVINGS BANK.

"many-storied" basis may sometimes compel the alternative of a sacrifice of either revenue or individuality, and the choice may be impelled toward reaping the more tangible harvest in rents; yet sometimes it may fairly be questioned whether this revenue is not of less value than the security and convenience with the reputation and prestige made possible by a building essentially and entirely a bank.

FIG. 16. BANK OF BUFFALO.

The subject is worthy of discussion. In the question of style the author ventures to support continued return to that distinctive type of bank which is recognized in so-called Colonial architecture by its classic proportions, its substantial, cultivated architectural detail of Renaissance style, its refined orders, and its graceful and reposeful domed ceilings and roofs. The New York Clearing House, of which a view is given (Fig. 11), is an example of an effort in this direction. In this instance an unusually rich treatment is accorded to express the responsibility assumed by such a building, representing the united banks of New York city,—the chief focus, in fact, of those interests in the United States. To stand worthily as the public manifestation of such a community, a building must avail itself of the highest and richest expressions of art, and must preach, not simply the utilitarian idea, but also a public spirited generosity and pride. Its site in the crowded and densely-built section of the metropolis, where observers are close to its walls, dictated a grand simplicity of composition, and

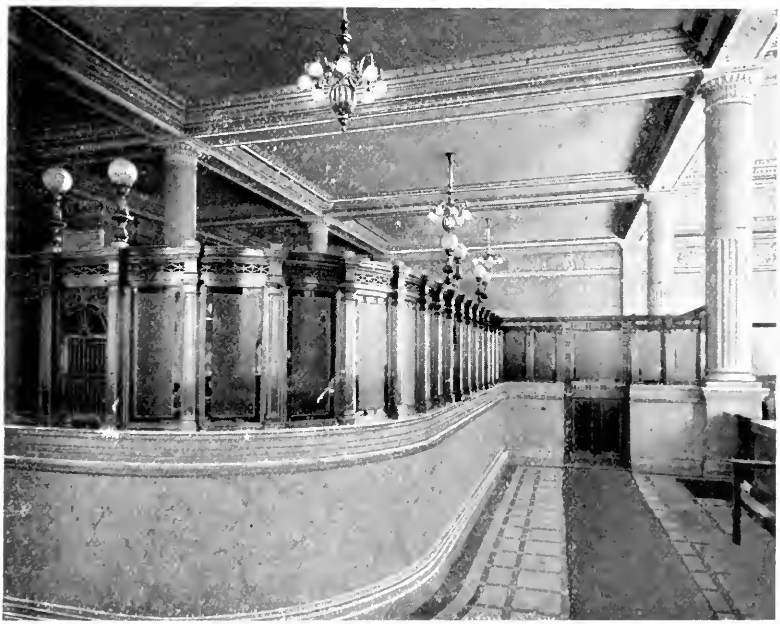


FIG. 17. COUNTER SCREEN. CHASE NATIONAL BANK.

at the same time a delicacy of detail. But there is no sacrifice of its useful purpose to ornamental effect. The windows are of great size; the exterior is the outgrowth of a plan devised for work. Within, the purposes of the building, unhampered by any demands for general tenancy, permitted of an artistic development of its own character. Its interiors are architectural as well as its façade. The manager's office (Fig. 12) and the clearing room (Fig. 13) are shown, to illustrate the individuality made possible by the lofty ceilings and regular spaces of a building designed for one purpose only.

It happens that the savings banks are to-day doing the foremost

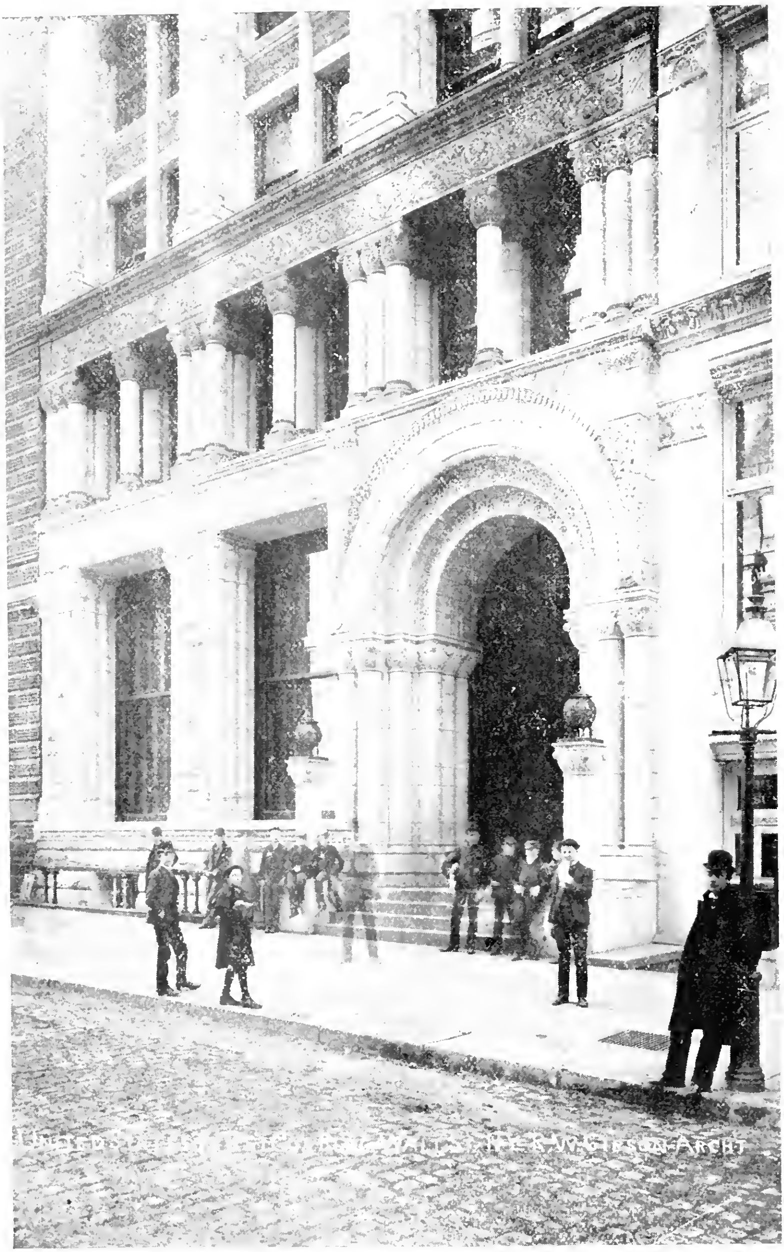


FIG. 18. UNITED STATES TRUST COMPANY'S BUILDING.

work in the cultivation of bank architecture. Owing to their peculiar circumstances, they find advantage where some other institutions are deterred. Commercial banks necessarily select for their reserve assets those investments which are easily convertible to use when needed, and only a fair portion of a considerable surplus can safely be devoted to such a "slow" asset as real estate of valuable character. Occasions may arise when the strength of the strongest bank is so taxed that not only the value, but the immediate availability, of its property is desirable. But the older savings banks, under their system of safe-keeping, have to deal with different conditions. The funds they receive are the *reserves* of their customers,—not their working capital. With their comparative security against urgent haste and panic, they can well afford to put part of their surplus into just such assets as land and buildings. The low rate of interest on the capital absorbed is compensated in the absolute security it offers. In short, every inducement which the commercial bank finds to build its own house is doubly strong for a savings bank.

We see continued work in this direction. The Greenwich Savings Bank, New York, having outgrown a building of the last generation, has erected that shown by Figures 14 and 15. It is a single great hall, with light on three sides and through the domes of the roof. Its dimensions—150 feet by 50—make its interior impressive, apart from its architectural features. The height is 65 feet,—more than is actually necessary internally, but desirable externally to give the building dignity among adjacent structures. The vertical character of our modern city buildings compels a revision of the system of proportion in street fronts. What would appear admirable in unprejudiced position might be dwarfed or distorted by association with the extreme contrast of lofty towers. Of course, there are several rooms of ordinary size in such a building as this; they are placed in a separate wing, which has four stories in the same total height.

The Bank of Buffalo (a commercial bank), shown on Fig. 16, is a building of the old type, modified for present conditions. To give it sufficient height to hold its own among lofty neighbors, as well as to make available a somewhat limited space, a second story is provided for directors' and other separate rooms, and the high dome which gives character to the edifice affords much valuable space.

A view of a part of the interior of the Chase National Bank, New York, is given in Fig. 17, which illustrates some of the new features, especially the absence of woodwork and the use of marble and bronze in its place.

As an example of a banking-room in connection with a high office-building, the view (Fig. 18) of the United States Trust Company's office in New York is given. A story of about twenty feet in height serves to distinguish the chief portion of the edifice from the parts which are rented, and an extremely massive and solid treatment of the granite pillars and arches expresses the qualities of permanence and strength.

Last mentioned in our list, but by no means least important, of the aims of a well-designed bank-building is comfort. The appliances for this purpose are less specialized, and are known by their use in many other buildings. Good ventilation is a foremost need. In the best modern work, it is made independent of the heating. The registers are for fresh air, not hot air. In winter it is, of course, warmed, but the heating is left to local management by direct radiators, or, better still, under control of automatic thermostats. Fans must be provided; they are the only positive producers of air-currents, and even these are usually neglected by ignorant engineers. Now that electricity is so generally available, the author advocates local control for these also,—several separate inlet and outlet fans of small size, which can be started and stopped by a push-button just as the light is managed. The usual way is still to collect the numerous ducts in a system, and lead them from or to a large fan. Lighting has many new appliances. It should be switched in distinct groups for use apart from other groups, and a special desk-light or counter-light should be provided to each individual. The electric elevator must also be noticed. It is superior for bank-work to the hydraulic, on account of its greater cleanliness, and also because it will stay where it is left, level with a floor,— an important quality if trucks or loads of heavy books are being handled on it. An elevator makes a basement under a chief department, or a gallery over it, nearer and more convenient than remote space on the same floor. It makes an attic a better storage-place than a basement, and equally accessible. It allows directors' rooms and other little-used departments to be put off the main floor where space is limited. It is invaluable. The desk telephone, too, is indispensable. This and the electric buzzer need no more than mention. Occasionally the pneumatic dispatch tube is a great labor-saver.

Outside of working departments, a modern bank will have much space devoted to its employees. A dressing-room is provided with a locker for each man, and sometimes, if space permits, a few gymnasium fittings; a dining-room, with pantry and caterers' entrance and conveniences in the basement, or with a kitchen with refrigerator and store-rooms, the latter arrangement usually in an upper story; and a room where one or two employees may sleep, if urgent night-work is demanded; and indeed more things than can here be mentioned.

DETERMINING THE VALUE OF AN IRON MINE.

By Nelson P. Hulst.

IN determining the value of an iron mine, one must apply very largely the rules or principles which are used in estimating the value of mines of the other metals; or the broader statement might be made that one must apply very largely the rules which are generally used in getting at the value of any other kind of mine. For, while every mine has more or less distinguishing features which affect most vitally its value, there are certain features common to all mines, which compel the effort to arrive at their value to conform to general lines. The standard by which the valuation must always be gaged is the earning capacity of the mine, the common standard which is used in estimating the value of any species of property. It will not do, however, to accept as an evidence of the earning power of a mine the cost-sheets or balance-sheets of its office. The system of accounts kept there must be thoroughly investigated, if the evidence of the books is to have any weight in determining the value. Either through heedlessness or by purpose, sometimes the balance sheets may show, or may be made to show, a gratifying profit in the mining work, by continually charging up to the inventory account, at full cost, the machinery and the various permanent improvements required for the business. Although these are thus made to appear as assets at full value, without qualification, the veriest tyro in the business knows, or ought to know, that their value is only that of tools which are steadily wearing out, like the shovels or hammers, or are becoming obsolete and must soon be abandoned for more economical ones which will place the mine at equal advantage with competitors, and that, in the event of the exhaustion of the mine, they can, at the very best, have only a tithe of the value accorded them in the book accounts. Nor, on the other hand, will it do to say of any mine that it is worthless because it has shown a debt-producing capacity, for the most superficial examination may show the unfortunate combination of a valuable mine and a poor manager. Judgment of a mine must, therefore, sometimes be independent of its existing management as well as of its books of account.

For the reason that there are a number of factors which go to make up the value of a mine,—factors which differ as mines differ, no two ever being just alike,—it becomes of moment, and it ought always to appear especially necessary to those purposing to invest in mines, that men of known capability in weighing the importance and relative weight of the several factors which limit the value of a mine should be selected to determine the value. It is in place here to enumerate the more important factors which affect the value of iron mines. They are as follows: magnitude of the ore body; accessibility to a point of consumption; market value of the ore; its chemical and physical qualities; freedom of the ore body from rock masses, as well as from lean or less merchantable ores; local relations affecting the mine; amount of water to be dealt with; timber supply. There are other less important conditions affecting the value of a mine, which cannot be so accurately estimated, and are not considered in this article, although they should have their measure of influence, small as it may be.

No attempt has been made in the enumeration here given to arrange the several factors in the order of their merit, as the relation of one to the other may be said to change with almost every mine. This difference in the relative importance of the several factors especially distinguishes iron from precious-metal mines. Accessibility to a point of consumption is always of the greatest importance in valuing the former; it has very seldom more than slight consideration when valuing the latter. As all know who are at all familiar with mines, it is a matter of minor importance, when considering a precious-metal mine, whether its location is within the bounds of civilization or at the ends of the earth, whether it is among the clouds or at the bottom of a river-bed, so long as the quality of its ore, its richness in the metal sought for, sufficiently exceeds in value the cost of its transportation. The cost of transportation may seem appalling, but it is, in fact, often a charge of inconsiderable weight compared with the tonnage of ore producing it; and, when it appears in mine costs distributed over this tonnage, it becomes an almost unnoticeable amount. The product of an iron mine is not thus reduced in weight by concentration. The freight charge it bears is on a very bulky material in comparison; and, while it is a commercial necessity that this transportation-cost be small per ton, it is in effect often larger than what appears as a freight charge in the distribution of such cost over the tonnage of a precious-metal mine. As freight costs on iron ore make up so often a very large part of its value, the accessibility of an iron mine—*i. e.*, its location at such a point as to command a freight cost on its product within the allowable limits—must be of chief importance. When an iron mine is so situated that the transportation of its product cannot be had, or cannot be hoped for, at such a rate per ton as will allow a satisfactory profit in the mine work, it is practically worthless.

There is the further difference between these mines that the product of the one (gold) has a stable value, while that of the other fluctuates. In times of financial depression, the former is affected profitably; the latter suffers in such seasons early and late. Although there are many complex problems to be encountered in attempting to arrive at the value of a precious-metal mine, it may be said that there are many intricate perplexities attending the labor of estimating with a fair measure of accuracy the value of an iron mine.

No argument need accompany the statement that the magnitude of an iron mine is of very great moment when considering its value. It is essential, however, to note, as between a large mine and a small mine, where the other conditions affecting value are relatively about the same, that the former has a value, when compared with the latter, in excess of the ratio of size. To simplify the argument, let us consider, not two mines of different size, but one mine producing different tonnages annually. The deductions made under such conditions, it is fair to believe, are equally applicable to mines of different sizes. To state it in the simplest terms possible, the value of a mine is just equal to the total available tonnage it can produce multiplied by the average net profit obtained on each ton of product and no more. The net profit realized on each ton for any one year is the difference between the cost of its production and the selling-price of it for that year. Always as a part of the cost of producing the ore, there are some expenses appearing on a cost-sheet which remain fairly constant per ton for a given tonnage. These are called fixed expenses, and include superintendence, office expenses, insurance, pumping, and certain labor at various points both on the surface and underground. If these fixed expenses for a product of 200,000 tons per annum are, say, 15 cents per ton, it is clear that they would be 30 cents per ton on an annual product of 100,000 tons, and just as clear that they would be 7½ cents per ton, if the product were increased to 400,000 tons per annum. It is to be noted also that the expenses incurred by very much of the dead work of a mine, as the sinking of shafts, driving of levels, etc., when distributed over tonnage product, are subject to the same rule that governs fixed expenses, with reference to increased or diminished tonnage. It is only a reasonable deduction from the foregoing that the ore product from a larger mine can be produced at a less cost per ton, and hence the larger mine should have value accorded it in a ratio greater than that represented by its difference in size from the smaller mine. This being the case, it is evident that, in estimating the value of a mine, different figures must be used according as the mine is large or small.

In arriving at the magnitude of an iron mine, if the development be supposed to be complete, the measurement of the ore reserves may be readily made, and the total tonnage computed therefrom when the specific gravity of the ore is known. But the tonnage thus computed cannot be accounted the total available tonnage. By no system of mining is it possible to remove all the ore, a greater or less percentage being wasted in the process of mining; nor are ore bodies usually free from rock masses. What allowance should be made for the ore lost in mining, or because of the presence of rock or of lean, worthless ore considered as rock, must be most carefully determined. If one is unfamiliar with an iron ore district where the mine to be valued is located, it is often a necessity that he study diligently both the ore and rock masses occurring in the mine. This is essential, as the ore of every mining district has distinguishing characteristics, and the same may be said of the rock occurring with the ore, which differentiates both of them from those of other regions, and which, if not fully appreciated, will lead one into error. Where the development has not been sufficiently complete, further development of the ore body may be necessary; and, if the expense it would involve cannot be incurred, then one must make the best study possible of near-by mines in the district, if such exist, to learn of the frequency of occurring rock in their ore bodies. In some instances the rock-dumps afford an indication of the prevalence of rock in the ore, which may assist one to some conclusion as to its percentage in the ore body. Each mining district is also more or less a law to itself as to geological features which affect the occurrence of and limits to ore bodies. In the Gogebic district of the Lake Superior region the prevalence of a system of dykes, great tilted planes of rock intersecting the ore bodies, are a notable feature. On the Menominee range of the Lake Superior region the lenses of ore exhibit a westerly pitch so generally that it is a characteristic for the district. The other so-called ranges of the Lake Superior region have also their peculiarities. Hence, in arriving at the magnitude of any ore body, there must be a proper knowledge of the geological features which are likely to affect it.

The factor of accessibility has already been considered in another connection, but it may be said further that in all cases accessibility is to be measured by freight costs only, not by miles of distance. The iron mines of the Mediterranean are very often more accessible to Atlantic coast furnaces than are the much less distant Lake Superior mines. Freight rates, moreover, should always be estimated by the percentage of iron the ore contains,—*i. e.*, the iron units. In thus considering freight rates, it appears that quality of the ore also must be considered in ascertaining the limits of accessibility of a mine.

The market price of iron ore necessarily affects the value of the mine producing it. For many years it has suffered frequent fluctuations in response to the ever-varying prices of iron and steel. This factor of market price of the ore, which determines the possible profits of mining and therefore the value of the mine, must be, not to-day's price per ton, or last year's, but the average price, as near as it may be ascertained, for such a period of time as may be judged to cover the profitable activity of the mine. The drift of business is to lower profits as individual enterprises grow larger. Within the past two years the market price of Lake Superior ores has sounded the lowest depths ever reached by them,—a price which meant dire loss to many mines. The price for this year may show a rebound of a dollar per ton, but this does not mean that such increase is all profit to the mine operator. Increased wages and increase of freights, as well as increased cost of supplies, make up a portion of the difference in price. To be able to compute with any degree of correctness the average price of iron ore for a period covered by the future, one must needs be a seer. But one can, without assuming such a *rôle*, read the signs of the times as indicating in all directions a trend to lower prices. It is a natural inference that the profits per ton in mining iron ore in the Lake Superior region are also likely to tend to a lower figure, especially when one observes that its most promising mining properties—*i. e.*, the mines now producing, and others likely to produce, the major portion of the ore—are becoming absorbed into the control of a few corporations. As these corporations have diminished in number, the mines which they control, where capable of it, have been pushed to an increased annual output. A single mine in 1892, the Norrie of the Gogebic range, produced 985,000 tons of ore, while, but twenty years earlier, all the active mines of the Lake Superior region, twenty-nine in number, produced but 949,000 tons. As showing how mines are beginning to be pushed for large annual output, it may be stated that for the year 1895 twelve mines in this region produced a total of 5,200,000 tons, or half the entire production, and some of these giants are just gathering their strength. It may not be safe to say for a decade hence that the product of less than twelve mines will constitute the major portion of the annual iron ore output of the region, but it seems entirely within bounds to make the affirmation that a very considerably less number than twelve corporations will control mines which will produce the major portion of it. It is still more reasonable to expect that this production of the major portion will be accomplished with greater economy of cost per ton than at present, and that a less profit per ton will satisfy; and this appears the more reasonable when it is considered that these fewer corporations will have other profits coming to them from the transportation of the ore, if not also from its conversion into metal. Other reasons could be recited, but they cannot be included in so brief a paper. A figure, therefore, which might be expected to represent the average profits on iron ore to be used as a factor in valuing an iron mine should, since it must depend entirely on future prices, be made a comparatively small one to insure a safe investment. But the valuation of a mine sometimes includes the fee of the property. In such instance the risk in the business is wholly on the part of the investor. When, on the other hand, the valuation is to be of the leasehold and improvements, if any, together with a bonus large or small, as the case may be, the risk is diminished, for the reason that the fee-owner shares with the mine operator in a part of the hazard attaching to a mining investment. For a valuation in the latter case, it is enough to determine whether there is a sufficient quantity of ore in the mine, as well as whether there is the certainty of an ample average profit from it which will more than make good to the lessee his expenditure for the lease and for such equipment as it may require.

The chemical quality of an iron ore is an important factor in determining its value, and in consequence that of the mine producing it, since iron smelting has attained to the dignity of a science by the precision of its work. The capable furnace manager of to-day either is an intelligent chemist or has at his command a chemical laboratory staff. Iron smelting is conducted by him with all the exactness of a laboratory experiment, so far as ores, fluxes, and fuels are concerned. To this end he must have an accurate knowledge of the various percentages of all the elements contained in an iron ore which will affect the quality of pig iron, as well as the slag-making constituents the ore contains. The higher the percentage of iron contained, the greater is its smelting value, except as it is limited by the character of the oxidation of the metal in the ore, it making a difference whether the metal exists in the form of a magnetic oxid or a sesquioxid. Phosphorus must be limited to a certain small percentage, varying with the use to which the pig iron is to be put. Sulphur is never admissible except in small percentages, unless it can be economically eliminated before reaching the furnace. The percentage of slag-making constituents of an ore affects fuel consumption and in so far as they enhance the freight on the units of iron contained in the ore, affects also the value.

The physical quality of the ore, so far as it affects the cost of smelting, affects its market value. A score of years ago it was almost a necessity that the operator of a mine producing soft hematite ore should have control also of a mine producing hard specular ore or magnetic ore, whereby he might be enabled to compel purchasers of the much-sought-after hard ores to accept with them from ten to fifteen per cent. of the much less desirable soft ores. A revolution has taken place in the ideas of blast-furnace managers as to the comparative value of hard and soft ores. Costly plants of crushing machinery have been installed at several of the largest hard-ore mines, mainly that their product may be made thereby to approach more nearly the desirable quality of easy reducibility possessed by the soft ores.

The writer quotes with justifiable pride from a pamphlet he wrote in 1875 presenting the claims of the soft-ore bodies of the then undeveloped Menominee range, to show his early conception of the relative values of the hard and soft ores of the Lake Superior region as affected by the cost of smelting them. "I call your attention particularly to the texture and quality of the samples of ore sent you. The distinctive feature of their open porous condition characterizes them advantageously as wholly unlike the hard ores of the Marquette district. They, as you know, are dense, close-grained in texture, and to such a degree impermeable to the reducing gases of the furnace that they are smelted with difficulty. Especially is this the case with magnetic ores. So, too, the friability of these Menominee (soft) ores, which renders mining easy and economical in all its details, and reduces expense upon them even to the last preparation of the ore suitably sized for charging into the furnace, accords a value to them not possessed by the hard ores mentioned."

The hardness of the ore produced by a mine affects materially the cost of mining it. Drill work becomes greatly more expensive as the ore grows harder. Not only does the labor cost of drilling, per foot, increase, but more power drills, more drill steel, more blacksmith and machine shop labor, more explosives, and more waste of time by powder gases, are found necessary to produce a given tonnage of hard ore than are required to produce an equal amount of soft ore. The ore broken by blasting comes down often in masses requiring block-holing and sledging before it can be loaded on cars, and much of it must be lifted into cars by hand rather than by shovel, all of which adds to the expense of mining; and then follows the final cost of crushing, before referred to. The expense of timber and timbering may be at a minimum in a hard-ore mine, but this economy is far outweighed by the economies attending the mining of soft ore.

The freedom of an ore body from rock masses and lean ore permits the application of the maximum of labor on the products ought. Not only is the mine labor more effective, because not wasted on useless material, but the straight-ahead work allows a systematization of it which insures the highest economy. Where rock masses occur, their avoidance, or their penetration in the prosecution of the so-called "dead work," is always a cause of much extra expense, while fragments of rock broken down with the ore vitiate its quality, if not picked out, and, if picked out, put a higher labor cost on the ore.

The local relations of a mine have an influence in affecting the cost of mining its product. When it lies close to the surface, or has a considerable portion of its tonnage situated so that it can be readily removed by open pit mining, the inexpensiveness of that system helps to a greater profit on the ore produced. The pumping cost is also at a minimum; or natural drainage may be possible. Local conditions affecting the cost of the installation of the surface equipment, and in a greater or less degree the cost per ton of ore, climatic conditions, and quality of labor all affect cost of production.

The water to be handled from a mine is more often than not a constantly increasing expense. Its volume may not grow larger as mining work extends downward, but the increased lift of a smaller volume may more than counterbalance the expense of handling it. In a region where a limestone formation overlies an ore formation, one may expect increased volume of water as depth is gained; for limestone, because of its ready solubility, is the home of subterranean water courses of great length and magnitude. The caving due to the mining of ore bodies so located is likely to open up connections with the water-courses of the limestone, and this water, once tapped, is always on draught.

The timber supply necessarily is a larger item with a soft-ore mine, as its levels, winzes, ore chutes, drifts, and cross-cuts need artificial support. Some methods of mining soft ore involve the use of less timber than others, but with the least expensive the cost is, in the aggregate, a considerable sum.

From the foregoing it is seen that the determination of the value of an iron mine is a many-sided problem. It involves, among other things, questions of business, of mining, of engineering, of chemistry. Only intelligent and conscientious effort can estimate the value of the different factors with any degree of accuracy. The questions to be solved require a thoroughly reliable, capable man,—one who is up-to-date in mining practice. He should be thoroughly conversant with the market value of iron ores and familiar with their chemical qualities. He should have a clear conception of the ways in which economies, big and little, are obtained in mining,—a conception which has been disciplined by successful superintendence of an iron mine, as well as by the studies of its cost-sheets. He should have wrought over the problems of the opening of iron mines and the adaptation and installation of mine equipments. Only a man thus qualified can be expected to furnish a reliable estimate of the value of an iron mine, or of the cost of opening and equipping it.

These considerations have application, directly or indirectly, to iron mines wherever located. Judgments of iron mine values must be based on the underlying principles noted, which have universal application to this species of property.

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Electrical Engineer. *w.* $3. New York
Electrical Engineering. *m.* $1. Chicago.
Electrical Industries. *m.* $1. Chicago.
Electrical Plant. *m.* 6s. London.
Electrical Review. *w.* 21s. 8*d.* London.
Electrical Review. *w.* $3. New York.
Electrical World. *w.* $3. New York.
Electrician. *w.* 24s. London.
Electricity. *w.* $2.50. New York.
Electricity. *w.* 7s. 6*d.* London.
Engineer, The. *s-m.* $2.50. New York.
Engineer, The. *w.* 36s. London.
Engineer & Contractor. *w.* $1. San Francisco.
Engineers' Gazette. *m.* 8s London.
Engineering. *w.* 36s. London.
Engineering and Mining Journal. *w.* $5. N. Y.
Engineering Magazine. *m.* $3. New York.
Engineering-Mechanics. *m.* $2. Phila.
Engineering News. *w.* $5. New York.
Engineering Record. *w.* $5. New York.
Engineering Review. *m.* 7s. London.
Eng. Soc. of the School of Prac. Sci. Toronto.
Eng. Soc. of Western Penn'a. *m.* $7. Pittsburg.
Fairplay. *w.* 32s. 6*d.* London.
Fire and Water. *w.* $3. New York.
Forester, The. *bi-m.* 50 cts. May's Landing, N.J
Fortnightly Review. *m.* $4.50. London.
Forum, The. *m.* $3. New York.
Foundry, The. *m.* $1. Detroit.
Garden and Forest. *w.* $4. New York.
Gas Engineers' Mag. *m.* 6s. 6*d.* Birmingham.
Gas World, The. *w.* 13s. London.
Geological Magazine, The. *m.* 18s. London.
Gunton's Magazine. *m.* $2. New York.
Heating and Ventilation. *m.* $1. New York.
Ill. Carpenter and Builder. *w.* 8s. 8*d.* London.
Improvement Bulletin. *w.* $5. Minneapolis.
India Rubber World. *m.* $3. New York.
Indian and Eastern Engineer. *w.* 20 Rs. Calcutta.
Indian Engineering. *w.* 18 Rs. Calcutta.
Industries and Iron. *w.* £1. London.
Inland Architect. *m.* $5. Chicago.
Inventive Age. *s-m.* $1. Washington.
Iron Age, The. *w.* $4.50. New York.
Iron and Coal Trade Review. *w.* 30s. 4*d.* London
Iron & Steel Trades' Journal. *w.* 25s. London
Iron Industries Gazette. *m.* $1.50. Buffalo.
Iron Trade Review. *w.* $3. Cleveland.
Journal Am. Chemical Soc. *m.* $5. Easton.
Jour. Am. Soc. Naval Engineers. *qr.* $5. Wash.
Journal Assoc. Eng. Society. *m.* $3. St. Louis.
Journal of Electricity, The *m.* $1. San Francisco.
Journal Franklin Institute. *m.* $5. Phila.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q.* $2. New London.
Journal Political Economy. *q.* $3. Chicago.
Journal Royal Inst. of Brit. Arch. *s-q.* 6s. London
Journal of the Society of Arts. *w.* London.
Journal of the Western Society of Engineers. *b-m.* $2. Chicago.
Locomotive Engineering. *m.* $2. New York.
Lord's Magazine. *m.* $1. Boston.
Machinery *m.* $1. New York.
Machinery. *m.* 9s. London.
Manufacturer and Builder. *m.* $1.50. New York.
Manufacturer's Record. *w.* $4. Baltimore.
Marine Engineer. *m.* 7s. 6*d.* London.
Master Steam Fitter. *m.* $1. Chicago.
McClure's Magazine. *m.* $1. New York.
Mechanical World. *w.* 8s. 8*d.* London.
Metal Worker. *w.* $2. New York.
Milling. *m.* $2. Chicago.
Mining. *m* $1. Spokane.
Mining and Sci. Press. *w.* $3. San Francisco.
Mining Industry and Review. *w.* $2. Denver
Mining Journal, The. *w.* £1. 8s. London.
Mining World, The. *w.* 21s. London.
National Builder. *m.* $3. Chicago.
Nature. *w.* $7. London.
New Science Review, The. *qr.* $2. New York.
Nineteenth Century. *m.* $4.50. London
North American Review. *m.* $5. New York.
Overland Monthly. *m.* $3. San Francisco.
Paving & Munic. Eng. *m.* $2. Indianapolis.
Physical Review, The. *b-m.* $3. New York.
Plumber and Decorator. *m.* 6s. 6*d.* London.
Popular Science Monthly. *m.* $5. New York.
Power. *m.* $1. New York.
Practical Engineer. *w.* 10s. London.
Proceedings Engineer's Club. *q.* $2. Phila.
Progressive Age. *s-m.* $3. New York.
Progress of the World, The. *m.* $1. N. Y.
Railroad Car Journal. *m.* $1. New York.
Railroad Gazette. *w.* $4.20. New York.
Railway Age. *w.* $4. Chicago.
Railway Master Mechanic *m.* $1. Chicago.
Railway Press, The. *m.* 7s. London.
Railway Review. *w.* $4. Chicago.
Railway World. *m.* 5s. London.
Review of Reviews. *m.* $2.50. New York.
Safety Valve. *m.* $1. New York.
Sanitarian. *m.* $4. Brooklyn.
Sanitary Plumber. *s-m.* $2. New York.
Sanitary Record. *m.* 10s. London.
School of Mines Quarterly. $2. New York.
Science. *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York.
Scientific Am. Supplement. *w.* $5. New York.
Scientific Machinist. *s-m.* $1.50. Cleveland, O.
Scientific Quarterly. *q.* $2. Golden, Col
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Journal of Eng. *m.* $2. Ithaca, N. Y.
Southern Architect. *m.* $2. Atlanta.
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago.
Technology Quarterly. $3. Boston.
Tradesman. *s-m:* $2. Chattanooga, Tenn.
Trans. Am. Ins. Electrical Eng. *m.* $5. N. Y.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* $10. New York.
Transport. *w.* £1. 5s. London.
Western Electrician. *w.* $3. Chicago.
Western Mining World. *w.* $4. Butte, Mon.
Western Railway Club, Pro. Chicago.
Yale Scientific Monthly, The. *m.* $2.50 New Haven.

ARCHITECTURE & BUILDING

See also "Civil Engineering" and "Domestic Engineering."

The Avery Architectural Library.

No more notable or valuable memorial of an architectural nature has been erected in America than the library in Columbia College which Mr. and Mrs. Samuel P. Avery have founded in memory of their son, Henry Ogden Avery. To the architects of New York and its immediate vicinity this great collection of books must always be an adjunct to their studies; to the architects of the whole country it is of positive value to know that at one place, at least, there may be found almost every architectural book of importance, from those of small cost to the most expensive, and an abundance of illustrative material quite unequalled by any other American library.

The catalogue of the collection has just been published,—a sumptuous volume of nearly twelve hundred pages, printed in the finest manner and a veritable memorial in itself. Some thirteen thousand volumes are now in the collection, which is constantly being added to, the original gift of thirty thousand dollars having been supplemented by many subsequent gifts. The selection of books has been made on a liberal scale, and includes representatives of all the arts allied to architecture, making it, in effect, a real art library. The architect may find here many costly books whose price places them quite outside the reach of ordinary folk, and the student may find ample material for the study of every important phase of architectural history. Upwards of two hundred sets of periodicals are included, a feature quite unique among the art libraries of the country.

Henry Ogden Avery, in whose memory this library has been founded, was a young man of brilliant promise, whose professional career was interrupted, almost on its threshold, by his untimely death. Of strong artistic tastes, surrounded by an artistic atmosphere almost from his birth, he perhaps would have chosen for himself the literary and illustrative memorial established by his parents. Certainly none could have been of greater utility to the art students, and the generous founders of the library are entitled to the heartfelt gratitude of those who profit by their liberality. The bringing together of the books of this collection in the five years which have passed since the first gift was made has been a work of no small magnitude. The selection has been made by Mr. George H. Baker, librarian of the college, Prof. W. R. Ware, and Mr. Russell Sturgis. These three gentlemen form a commission, of whom the first two are always to be represented by their successors, with whom is lodged the choice of a successor to Mr. Sturgis, who must be an architect not connected with the college.

It is needless to add that in the accomplished hands of these gentlemen Mr. and Mrs. Avery have had their wishes carried out in the most careful and thorough manner. It is not an antiquarian collection, but a generously-conceived architectural library. It must materially add to the artistic supremacy of New York, should that distinction ever be disputed by other American towns.

Some German Buildings.

THE drawings published in the German architectural paper, *Architektonische Rundschau*, of Stuttgart, afford an interesting insight into a phase of current architecture we scarcely know in America. We have, it is true, many buildings which we rightly classify as German, not only from the fact that their architects are of German extraction, but because of that uncertain quality of art which we instinctively recognize as of that nationality. The illustrations of the *Rundschau*, of which five parts for the current year have appeared, are not, as a whole, notable. Like the English and American architectural papers, this periodical has to depend, to a certain extent, on what it can obtain. Its drawings, therefore, exhibit what may be termed ordinary buildings rather than important or notable ones. The villa reproduced herewith is, perhaps, better than the average. There is a sufficient sense of the picturesque in the general arrangement of the masses, but the design is hopelessly ruined by the coarseness of the detail, and the ugliness of the motifs. The gable, of which only a portion is seen in this drawing, is a thoroughly German feature, and its effect is greatly weakened by being supported on a column standing free on one corner. The stair windows on the side are hopelessly injured by the diagonal line at their base, which corresponds to no other feature. Another country-house embraces many more oddities, including a circular projection on one front capped by a rectangular and projecting headpiece in the roof. A church has a singular buttress-like feature of open arches at one side, with triple plain panels above the main door in the tower forming the chief feature of the front, which are cut off in an exceedingly naive manner above a circular window over the entrance porch.

It would be unfair to the best spirit of modern German architecture to take these pictures as illustrating the highest phase of German art; yet, as they appear in a leading German technical journal, it is impossible not to feel that we have at least types of average work, if no more. *The Builder*, of London, has recently published some large German buildings, one of which, the elevation of the new imperial courts of justice at Leipsic, was reproduced in these pages last month. This month it publishes the new National Bohemian Museum at Prague, and the Palace of the Prussian Diet, Berlin, of which the last is illustrated herewith. Other drawings have been published in the American papers. While it is a most excellent thing to learn what other nations are doing in architecture, it is not a little satisfactory to find that our own architects are doing so much better work, as a rule, than foreigners. We have not yet produced in this country masterpieces like the Paris Opéra or the Musée Galliera, which the French architects occasionally produce. But this is because we have no opportunities for such work rather than because of the inability of our architects to produce them.

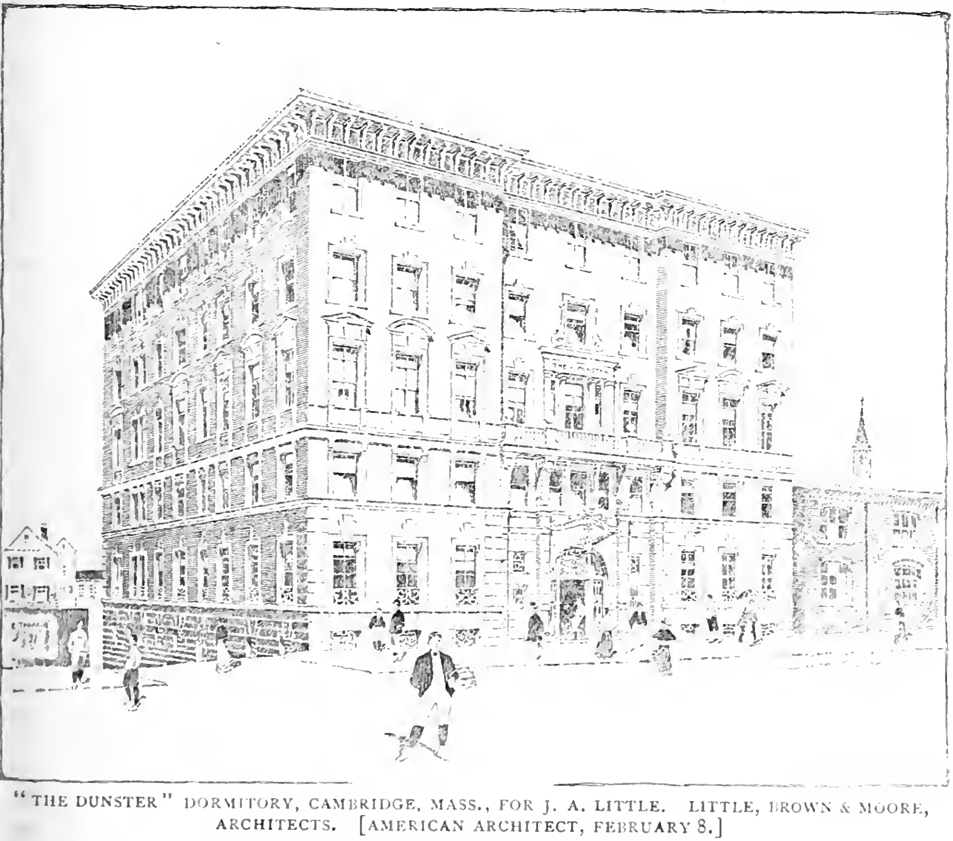
The most distinguishing note of American architecture is its feeling for the picturesque, and very successfully do American architects interpret this delightful architectural quality. In the German designs there is much the same spirit, without any appreciable ability of interpretation. That is to say, the houses, where possible, are broken into masses, the roof lines are varied, and not a few picturesque devices introduced.

Illustrations of the Month.

THE *Inland Architect* for February prints the accepted and the second premiated designs for the library of the University of Wisconsin; the other designs in this competition were published in a previous number and commented upon in our January issue. The accepted design, by Messrs. Ferry & Clas, of Milwaukee, shows many changes as compared with the first design of the same architects. The pedimented portico, which is the feature of the main front, is lifted onto a basement, the original flight of steps being suppressed, — an arrangement certainly much more suited to the climate of Madison than that devised by the Greeks. The whole building, in fact, is now raised on a basement, the front broadened, the wings shortened, and the low dome brought forward and raised somewhat, so as to become an absolute feature of the façade. On the whole, the changes are for the better in every way. To treat the first story of a building as an architectural basement, as has been done in this instance, has the support of long-standing precedent, and is at the same time a perfectly legitimate device. Yet it may be questioned if there is not too great a tendency to build basements for the simple reason that they afford a means of lifting the structure up so that it can be seen. That the exterior treatment of a building logically begins with the emergence of its walls above the ground needs no argument; but is it absolutely necessary to build up one story before we can begin to show off our columns and our pilasters, our windows and our niches? If there are precedents for basements, there are quite as many for buildings without them. A basement is often not only useful, but necessary; but we need not, on that account, insist on it in every considerable design.

The *American Architect* continues its illustrations of the interiors of the Metropolitan Club House in New York with three superb photographs (Feb. 8). These gorgeously-decorated rooms are in striking contrast to the views of the Sainte Claire Club House at San José, Cal., by Mr. A. Page Brown (Feb. 1), whose death in the same month was a serious loss to architecture on the Pacific slope. The latter design is charming and unpretentious, quite simple, and yet highly effective with its ample wall spaces and severe fenestration.

Two photographs and a plan illustrate the recently-completed city hall of Paterson, N. J., by Messrs. Carrère and Hastings. It is a fine design, carried out with that scholarly feeling which Mr. Hastings has taught us to look for in his work. The detail is less abundant than in many of his earlier buildings, and much strength is gained by relative simplicity. The design consists of a basement and two stories, treated with large Corinthian pilasters which support the entablature with which the building is crowned. In the center, boldly rising directly behind the balustrade of the roof, with which it is connected by a broken curved pediment at the base, is a square tower crowned with a small dome. It was, perhaps, a venturesome thing to design a tower rising in this way out of the roof, close to the front wall, yet not visible in it; but of the completeness of its success there can be no question. Not the least interesting feature is the fact that the main cornice is literally at the top of the building, and is thus

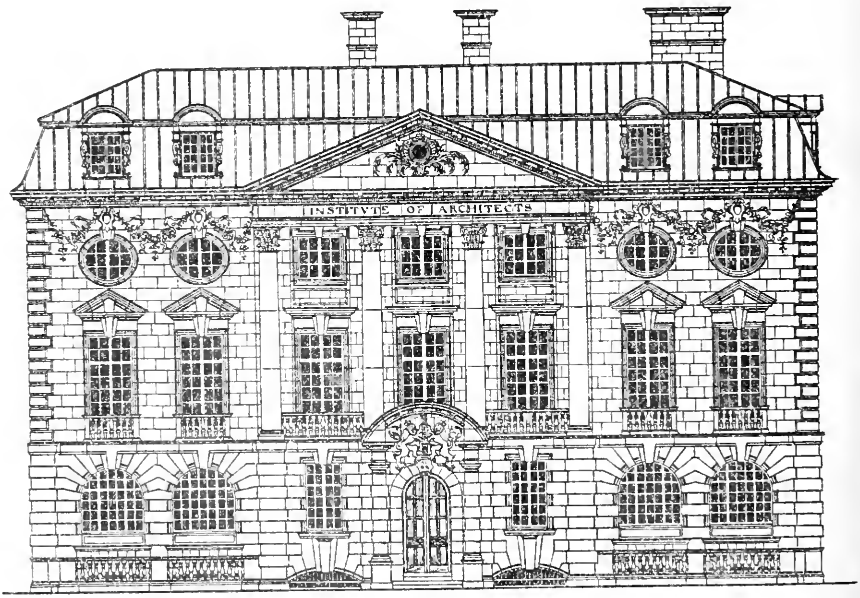


"THE DUNSTER" DORMITORY, CAMBRIDGE, MASS., FOR J. A. LITTLE. LITTLE, BROWN & MOORE, ARCHITECTS. [AMERICAN ARCHITECT, FEBRUARY 8.]

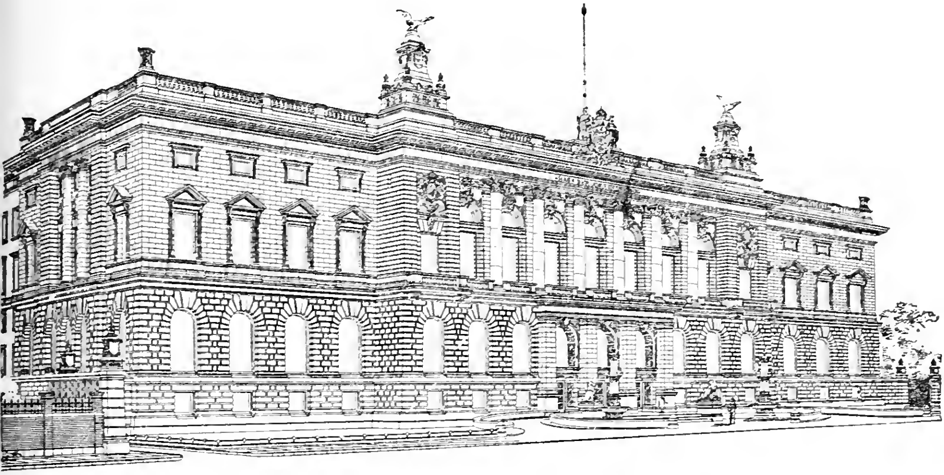
its natural crown and finish. Usually Mr. Hastings places his cornices part way down his façades, and has not escaped that habit in the tower of this building. This is easily one of the most notable buildings in New Jersey, and the lesser cities of that State, and of other States, will do well to study it and profit by its example.

The splendid art of the Paterson city hall rather casts in the shade some examples of municipal architecture published in the same journal. The accepted competitive design for city hall, station house, and jail at Cohoes, N. Y., excites wonder that it should have been necessary to go to Topeka for an architect,—and wonder also as to the nature of the other designs submitted for this competition, when the successful one is so commonplace. The Wayne county jail and sheriff's residence at Detroit is an unpretentious design, not nearly as formidable as the building of the Chicago Historical Society illustrated in the same journal. Of country-houses the most notable are a group of three for Bay Ridge, N. Y., including one for the architect by Mr. A. E. Parfitt. Several more pretentious designs are printed, but none of note. One of the largest is an example of that unnecessary copying of Colonial detail which passes, in many quarters, for so excellent art at this day. A design for a town hall at East Orange, N. J., is one of the many instances we see now-a-days of the use of classic columns as the leading *motif*. The same may be said of the Pope Monument in Boston,—a Doric portico of four columns irregularly spaced, and therefore quite wanting in that classic truth which its designers evidently imagined they were securing.

The photographic illustrations in *Architecture and Building* include the residence of W. V. Lawrence in New York, by the late R. M. Hunt. This may be profitably compared with the house for Mrs. Schmid by his son, published in an earlier number of the same paper. The general *motif* of the two designs is the same,—a circular turret on the avenue corner, with the entrance front on the cross street. The younger Hunt's design is richer than the elder's, on which it is frankly based. The Seton Hospital at Spuyten Duyvil, N. Y., is a simple, well-composed structure, with an enriched central pavilion to give it necessary relief and character. A mer-



SOANE MEDALLION PRIZE DESIGN, 1896. AN INSTITUTE OF ARCHITECTS, BY R. S. BALFOUR. [THE BUILDER, FEBRUARY 8.]



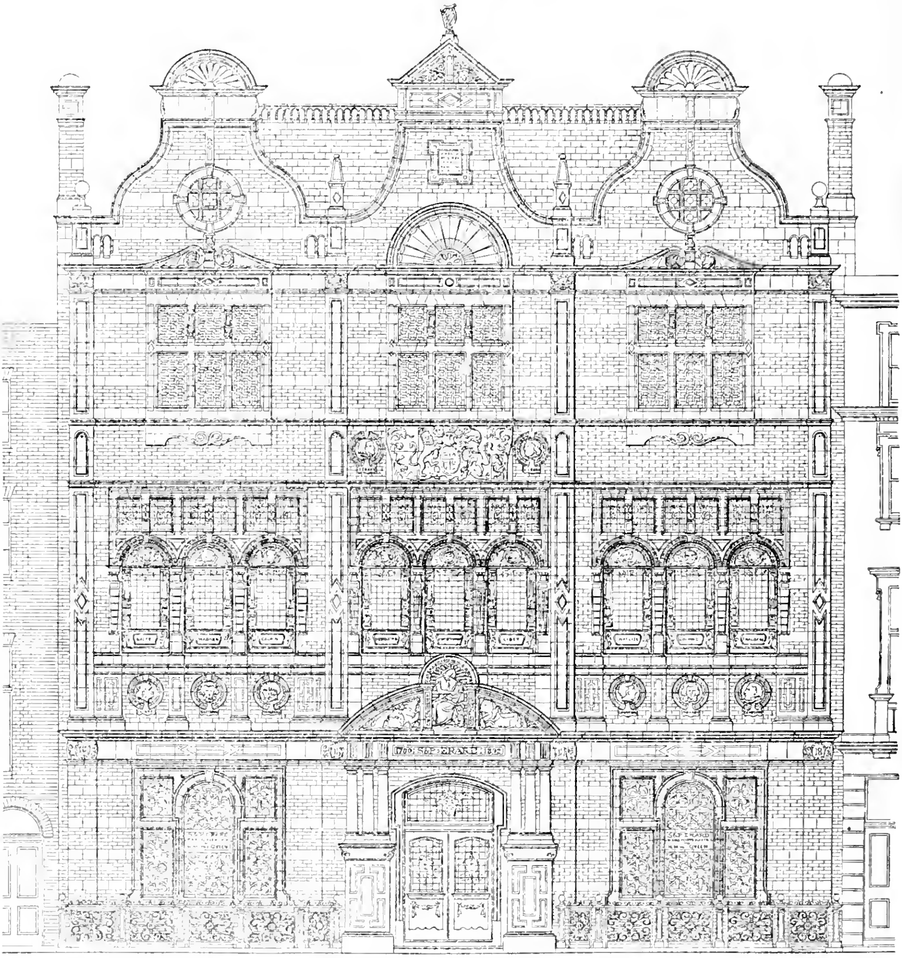
PALACE OF THE PRUSSIAN DIET, BERLIN. FRIEDERICH SCHULZE, ARCHITECT.
[THE BUILDER, FEBRUARY 22.]

cantile building at Fourth and Greene streets, New York, is a type of the commercial buildings in that locality, many of which are built by architects of German extraction. It is a piled-up design, with many features in the different stories, and yet without any especially marked anachronisms. The most important public building illustrated in this journal is the State Library and Executive building at Harrisburg, Pennsylvania,—a two-story structure, of which the first floor is plainly treated as a basement, and the upper with ornamental windows and porticoes in the main pavilions. It is a design quite lacking in dignity, owing to the many breaks in the façades, and, so far as the photograph shows, lacking as well in refinement.

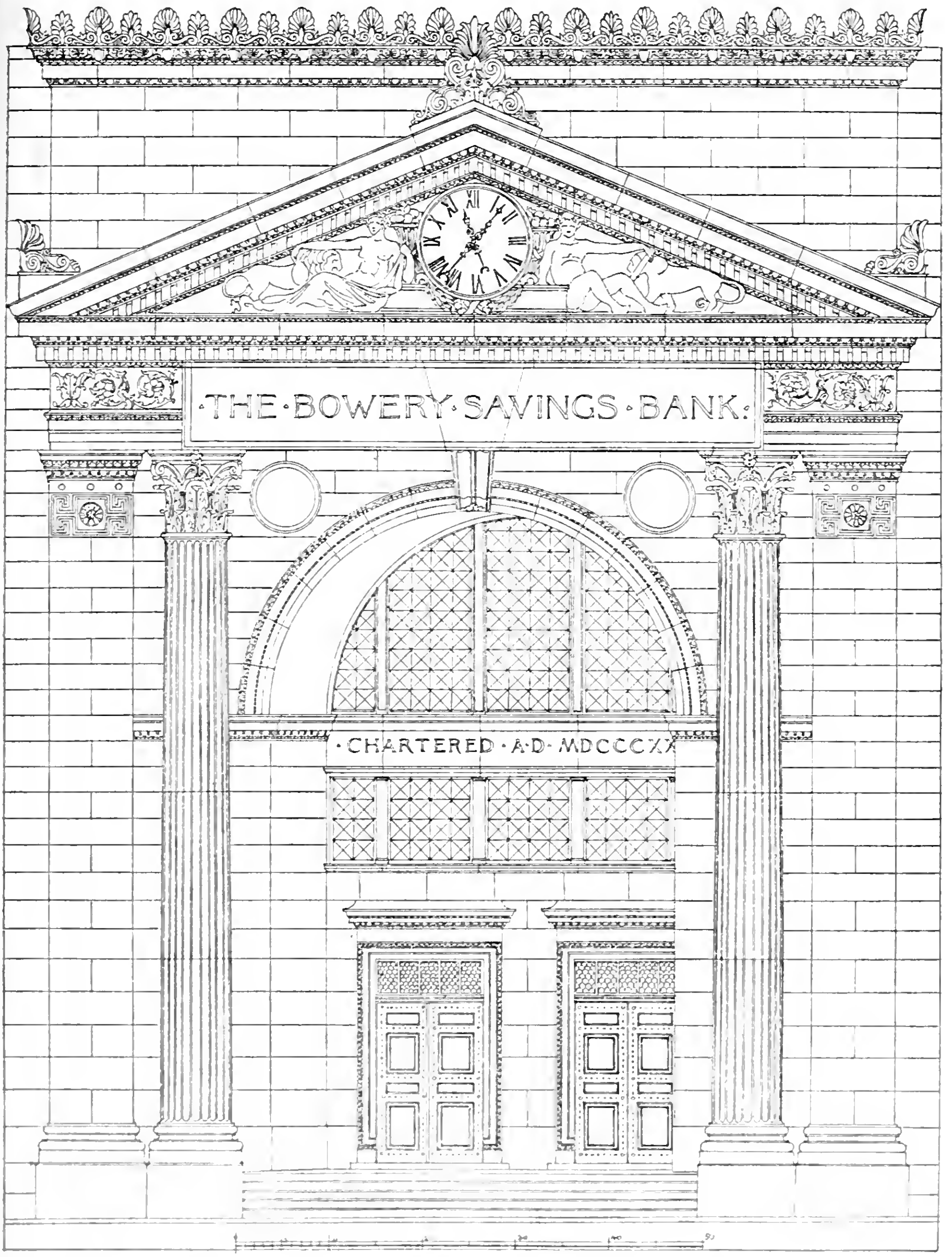
The most notable illustrations in *The Builder* are of German buildings. One, the palace of the Prussian Diet, is reproduced herewith. The leading *motifs* are obviously borrowed from the Italian Renaissance, but the architect has shown himself incapable of throwing off the traditional German influence. Much more marked in German feeling is the building of the National Bohemian Museum at Prague. A portico with long colonnades on either side forms the chief feature of the façade, a high square lantern or tower with four-sided dome marking the main entrance, and four smaller domes the corner pavilions. This journal also publishes a fine design for a summer cottage by Mr. Ashton Webb, a well-composed house in domestic Gothic that is quite as elaborate as some American country-houses. A suburban residence by Mr. A. M. Poynter is most unnecessarily bald and simple. As an example of the work done by English architectural students, some interest attaches to the Soane medallion prize design for an Institute of Architects, a thoroughly English classic design, as far removed from the "classic" studies of American students as it is possible for any type of classic architecture to be. In this country we fashion our classic structures after the French mode; the English have at least a type of their own that justifies such studies as this. Much more valuable, and a type of work we cannot have in this country, because we have no historical monuments, is a measured elevation of the Horse Guards in London, also published in the *British Architect*. The business block in Great M rlborough street, London, reproduced in these pages, is interesting as a style of building much affected by contemporary English architects. That this design suffers from over-elaboration of parts goes without saying, but it is valuable in showing the exceedingly clever manner in which many English architects combine vertical and horizontal lines in their design. Here both of these elements are distinctly marked, yet the result, as a whole, is entirely homogeneous and complete. American architects have not yet learned to use both these elements in a single design with the success which the British architects have achieved. Either one or the other predominates in American designs, or, if both are freely used, the result is a series of features built one on top of the other, instead of the unity which the English architects attain.

The Architect is performing good service in printing large photographs of important English buildings,—a work no other English architectural journal undertakes. As a rule they are well printed, and of sufficient sizes to bring out the detail sufficiently. A dining-room restored by Messrs. Ernest George and Peto is among the illustrations of the month.

The Brickbuilder publishes two elevations, a section and a sheet of plans of St Luke's Hospital in New York. From the text, which is not critical, we learn that the disposition of the space in floor-plans has been admirably disposed. This statement is hardly supported by the plans themselves, the pavilions being grouped together in a crowded fashion. Only a



A BUSINESS BLOCK IN LONDON. REMODELED BY P. G. STONE, ARCHITECT.
[THE BUILDER, FEBRUARY 15.]



BOWERY ELEVATION OF THE BOWERY BANK BUILDING, NEW YORK. McKIM, MEAD & WHITE, ARCHITECTS. [ARCHITECTURAL REVIEW, JANUARY.]

portion of the buildings have been erected as yet, and the very considerable amount of air and sunlight which the pavilions receive is no criterion of the condition of the building when finally completed. As a design, the façade is sufficiently dignified and supplied with enough in the way of architectural adornments to make it a notable addition to the great buildings of the metropolis. Ornamental qualities,

VILLA MENZER IN NECKARGEMUND. L. SCHAFER, ARCHITECT. [ARCHITEKTONISCHE RUNDSCHAU.]

however, do not make a hospital successful.

The Architectural Review, in its first number of the year, prints detail drawings of the Bowery Savings Bank, one of which is reproduced in these pages, and an elaborate series of drawings of the new public library at Fall River, Mass. Of the former it need only be said that it is quiet and refined and well-studied; which, being translated into the vernacular, means that it is commonplace. And that its commonplaceness is unobtrusive and good of its kind is the best that can be said for it. Of the Fall River library the *Review* itself obligingly furnishes the criticism. "It is," it says, "very good in some respects and disappointing in others. The different motives which compose the façade are much out of scale with each other. The general conception is of a simple, dignified building. The entrance and entire treatment upon the axis is out of accord with the conception, and has too many and too small parts." And so on, and so on. The manner in which praise and condemnation alternate in these remarks is very interesting. But this is a genuine specimen of Bostonese architectural writing.

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Hospitals.—St. Luke's Hospital, New York (elevation, section and plans), by E. Flagg, Brick., Feb.—Seyton Hospital, Spuyten Duyvil, N. Y., Shickel and Ditmars, Archt. and Build., Feb. 1.—Heath Convalescent Home, Llanfairfechan, North Wales (2), by T. Bower, Archt., Feb. 14.

Hotels.—Halcyon Inn, Little Tupper Lake, Adirondack Mountains, by F. M. Comstock, Archt. and Build., Feb. 29.

Houses, City.—For W. V. Brokaw and Mrs. B. Gilbert, Fifth avenue, New York, by H. F. Kilburn, Archt. and Build., Feb. 8.—Row, East 76th street, New York, by A. M. Welch, ibid., Feb. 15.—For G. W. Shiebler, Brooklyn, N. Y., by F. Freeman, ibid., Feb. 22.—On West 80th street, New York, by A. M. Welch, ibid.—At Buffalo, N. Y., by E. G. W. Deitrich, ibid.—For W. V. Lawrence, 78th street and Fifth avenue, New York, by R. M. Hunt, ibid., Feb. 29.—Block of Basement Houses, by J. B. Lord, Amer. Archt., Feb. 1.—For R. McK. Jones, St. Louis, by Eames and Young, ibid., Feb. 15.—For G. B. Carpenter, Chicago, by Treat and Foltz, ibid., Feb. 22. — For H. C. Chivers, Architect, St. Louis, In. Archt., Feb.—For J. C. Roberts, St. Louis, by J. B. Long and Co., ibid.—For E. H. Terrell, San Antonio, Tex., by A. Giles and Guindon, ibid.—For Dr. G. H. Bartlett, Buffalo, by W. W. Johnson, ibid.—For B. S. Thompson, Detroit, by Mason & Rice, ibid.—For Mr. Long, Detroit, by Rogers & McFarlane, ibid.—For E. A. Osburn, by J. Scott & Co., ibid.—For A. B. Towers, Chicago, by G. W. Maher, ibid.—For Emmons Blaine, Chicago, by Shepley, Rutan and Coolidge, ibid.

Houses, Country.—At Haslemere, Eng., by E. Newton, Brit. Archt., Jan. 31.—For A. B. McKechnie, Milliken Park, Renfrewshire, N. B., (two views and plan), by C. Davidson, ibid., Feb. 21.—Frensham Hall, Haslemere, Eng., by Beazley and Burrows, Builder, Jan. 25 —At Knutsford, Cheshire, Eng., by J. Brooke, ibid.—In Isle of Wight, by A. Webb, ibid.—Mansion, Folkestone, Eng., by G. H. Gordon, ibid., Feb. 1.—Design for a Suburban House (with plan), by A. M. Poynter, ibid., Feb. 22.—For W. H. P. Acton, Ont., by J. A. Ellis, Can. Archt., Jan.—For W. E. Vyse, Babylon, N. Y., by C. K. Birdsall, Archt. and Build., Feb. 8.—Cottage, Bayshore, N. Y., by same, ibid.—For W. Shiffer, Arverne, N. Y., by Parfitt Bros., ibid., Feb. 15.—For J. S. Stearns, Madison, N. J., by Stephenson and Greene, ibid., Feb. 22.—For M. A. Collins, Germantown, Phila., by C. H. Kirk, ibid.—At Bay Ridge, N. Y., by A. E. Parfitt, Amer. Archt., Feb. 8.—At Chicopee Falls, Mass., by G. Kirkham, ibid.—For A. W. Pope, Wellesley, Mass., by H. M. Stephenson, ibid.—Another, by same, ibid. — For Harriman Bros., Annisquan, Mass., by D. H. Woodbury, ibid., Feb. 22.—For M. K. Green, Jamaica Plain, Mass. (2), by Rand & Taylor, Kendall & Stevens, ibid.—For C. B. Appleton, Brookline, Mass. (with plan and interior), rebuilt by Kingsbury and Richardson, ibid., Feb. 29.—For J. MacMeans, North Edgewater, Chicago, by G. W. Maher, In. Archt., Feb.—For J. C. Scales, Buena Park, Chicago, by same, ibid.

Interiors.—Three Studies for Hall, by W. T. Barlow, Builder, Feb. 1. — S. Michael and All Angels, Colehill, Wimborne, Eng. (view, altar and pulpit details), by W. D. Carcöe, ibid., Feb. 15.—Arcade Building for Dickson and Talbott, Indianapolis, by Vonnegut & Bohn, In. Archt., Feb.—Dunblane Cathedral, N. B. (pulpit and organ details), Archt., Jan. 31.—Dining Room, West Dean Park, Singleton, near Chichester, ibid., Feb. 21. — Ste. Claire Club-House, San José, Cal. (parlor and entrance hall), by A. P. Brown, Amer. Archt., Feb. 1.—Residence, Lord Leighton, London (corridor), by G. Aitchison, ibid.—Metropolitan Club, New York (dining room, ladies' dining room, billiard room, and mantel detail), by McKim, Mead and White, ibid., Feb. 8.—Residence, Lord Leighton, London (Arab Hall), by G. Aitchison, ibid. (picture room), by same, ibid., Feb. 15. — For M. K.

Green, Jamaica Plain, Mass. (hall), by Rand & Taylor, Kendall & Stevens, ibid., Feb. 22.—St. Peter's, London (chancel), by A. W. Bloomfield, ibid.—For C. B. Appleton, Brookline, Mass., by Kingsbury & Richardson, ibid., Feb. 29.—Staircase, Gosford House, England, by W. Young, ibid.—University of Wisconsin, Madison (reading room, accepted design), by Ferry & Clas (reading room and rotunda, second premium design), by Van Brunt & Howe, In. Archt., Feb.

LIBRARIES.—Public Library, South Audley street, London, by A. J. Bolton, Archt., Feb. 7.—Technical Institute and Public Library, West Ham, Eng., competitive design for, by Newman and Newman, ibid.—Libra y University of Wisconsin, Madison (design in first competition, also accepted design with plan and interior), by Ferry and Clas, In. Archt., Feb.—The same (second premium design with plan elevation and interior), by Van Brunt and Howe, ibid.—South Orange, N. J., Free Circulating Library (2), by DeW. Clinton, Jr., and W. M. MacCafferty, Archt and Build., Feb. 1.—State Library and Executive Building, Harrisburg, Pa., by J. T. Windrim, ibid., Feb. 15.—Public Library, Fall River, Mass. (elevation, section and plan), by Cram, Wentworth and Goodhue, Archt. Rev., Jan.—For Newton Theological Seminary, Newton Centre, Mass., by Rand & Taylor, Kendall & Stevens, Amer. Archt., Feb. 22.—Proposed "Fiske Memorial Library," Boston, Mass., by D. H. Woodbury, ibid., Feb. 29.

MONUMENTS.—Emile Augier, Place de l'Odéon, Paris, by M. E. Barrias, Builder, Feb. 1.—Messonier, "Jardin de l'Infante," Louvre, Amer. Archt., Feb. 1.—Pope Tomb, West Hills Cemetery, Boston, by Dwight and Chandler, ibid.—To the Conception, Naples, ibid., Feb. 29.—Argyll Monument, S. Giles' Cathedral, Edinburgh, by Sydney, Mitchell and Wilson, Archt., Feb. 21.

MUNICIPAL BUILDINGS.—Chief Constable's House, Stafford, Eng. (2), by H. T. Hare, Brit. Archt., Jan. 24.—Town Hall, East Orange, N. J., by J. D. Matthews, Amer. Archt., Feb. 1.—City Hall, Cohoes, N. Y., Holland and Co., ibid.—City Hall, Paterson, N. J. (2), by Carrère and Hastings, ibid, Feb. 15.—County Jail and Sheriff's Residence, Detroit, Mich., by J. Scott and Co., ibid, Feb. 22.—New Record Offices, London, by J. Taylor, ibid.—Town Hall, Clerkenwell, Eng. (with detail of door), by C. E. Vaughan, ibid, Feb. 29.

MUSEUMS.—National Bohemian Museum, Prague (with plans), J. Schulz, Builder, Feb. 1.—Proposed Building for Archaeological Society, by E. Boué, Amer. rcht., Feb. 15.—Chicago Historical Society, Chicago (2), by H. I. Cobb, ibid.

PUBLIC BUILDINGS.—State Library and Executive Building, Harrisburg, Pa., by J. T. Windrim, Archt. and Build., Feb. 15.—Palace of the Prussian Diet, Berlin (with plan), by F. Schulze, Builder, Feb. 22.

SCHOOLS.—St. John's Seminary, Wonerish, Surrey, Eng., by F. A. Walters, Builder, Jan. 25.—Competitive designs for Technical Institute and Public Library, West Ham, Eng., Archt., Feb. 7.—Barnes Medical College, St. Louis, by J. B. Legg and Co., Archt. and Build., Feb. 22.—Dunster Dormitory, Cambridge, Mass., for J. A. Little, by Little, Brown and Moore, Amer. Archt., Feb. 8.

STUDENTS' WORK.—Drawings of Theatre of S. Carlos, Naples and Alcazar, Toledo, by J. S. Stewart, Brit. Archt., Feb. 7.—Design for Country Bank, by T. G. Lucas, ibid, Feb. 14.—Country House and Garden, by R. S. Balfour, ibid, Feb. 21.—Saone Medallion design for an Institute for Architects, by R. S. Balfour, Builder, Feb. 8.—Design for Jewelry Store, by E. H. Russell, Can. Archt., Jan.—Design for Lodge, by W. P. Over, ibid.—Design for Lodge, by C. D. V. Hunt, Archt. and Build., Feb. 8.

Leading Articles.

*4080. The Architecture of Modern Bank Buildings. Ill. R. W. Gibson (Explaining the requirements of different types of banks in the matter of interior space arrangement, and the methods of meeting these). Eng Mag-March. 3500 w.

4172. Classic Architecture. Henry Van Brunt (From the point of view of an architect. A discourse before Johns Hopkins University). Sci Am Sup-Feb. 15. 4400 w.

4190.—75 cts. From Liverpool to London. Wilson Eyre, Jr. (An account of a sketching trip for architectural study. Illustrated description mostly of domestic work). Arch Rev–Vol. IV. No. 1. 1200 w.

4195. Every-Day Italy. Claude Fayette Bragdon (Illustrated description of travels for architectural study. The first part gives an account of Turin, Genoa, and Siena). Am Arch–Feb. 15. Serial. 1st part. 4400 w.

*4268. Evolution of Design (Editorial comment on the tendency to take an evolutionary view of everything, and its application to the study of design in architecture, with reference and remarks concerning a late book by Alfred C. Haddon). Builder-Feb. 8. 2800 w.

*4269. Romanesque Architecture (The first Royal Acad. lecture on architecture by Prof. Aitchison. The object of these lectures is to advance and improve architecture). Builder–Feb. 7. 7000 w.

*4294. Service Reservoir at Buenos Ayres (Illustrated description of this handsome feature of the city. The style of architecture is French Renaissance, with terra-cotta decorations). Engng–Feb. 7. 700 w.

4368. Doorways of the Cathedral of Mayence. A. B. Bibb (An illustrated historical outline in the main translated from "*The Cathedral of Mainz*," by Herm Emden, with notes by the translator). Am Arch-Feb. 22. 1500 w.

4369 The Use of the Grotesque in Sacred Architecture. Rev. Frank Sewall (A "sermon in stones" The sacred meaning that enters into the features of the building in the construction of churches). Am Arch–Feb. 22. 2200 w.

*4371. The Making of Architecture. George

Aitchison (Extracts from a lecture delivered at the Royal Academy). Brit Arch–Feb. 14. 3000 w.

*4372. Florentine Villas. Lee Bacon (An interesting illustrated description of these villas, written in popular style). Scrib Mag–March. 7000 w.

4395. Fire Department Headquarters, Boston, Mass. (Illustrated description of a new fire department building in Boston, Mass). Eng Rec–Feb. 22. 2000 w.

*4407. Romanesque Architecture. Prof. Aitchison (The Second Royal Academy lecture on architecture this session). Builder–Feb. 15. 4000 w.

4439. The Olympion at Vienna (A brief description of an important building, to cost over $500,000, designed for the study of musical art, and the practice of many sports and pleasures, serving at the same time as a home for about eighty clubs, and a place where entertainments and festivals of all kinds can be held). Sci Am Sup–Feb. 29. 900 w.

*4461. High Buildings. C. H. Blackall (A defense of tall buildings by one who believes in them). Br Build–Feb. 3500 w.

4485. The Beginnings of Gothic Architecture (Illustrated description and historical account of the earliest Gothic construction). Arch & Build–Feb. 29. Serial. 1st part. 3000 w.

4486. Archaeological Remains in Arizona (Interesting reports, from the *N. Y. Sun*, regarding the discovery of relics of the cave-dwellers and cliff-dwellers). Arch & Build–Feb. 29. 1000 w.

*4487. The Avery Memorial Library. Barr Ferree (A brief account of the architectural library connected with Columbia College, endowed in memory of Henry Ogden Avery. It is a general reference library, designed for the advanced student and the architect). Jour Roy Inst of Brit Arch–Jan. 23. 1800 w.

*4488. Westmoreland Slates: Their Geology, Chemistry, and Architectural Value. J. J. Thomas (The magnitude of the industry; its importance; its geological position; chemical composition; method of preparing, etc). Jour Roy Inst of Brit Arch–Jan. 23. 5800 w.

†4489. Wood-Carving and Wood-Carvers. W. H. Romaine-Walker, W. Aumonier, J. E. Knox, and W. S. Frith (Four interesting scholarly addresses, finely illustrated, on the above subject). Jour Roy Inst of Brit Arch–Feb. 6. 11000 w.

†4490. American Architecture and Architects, with Special Reference to the Works of the Late Richard Morris Hunt and Henry Hobson Richardson. John B. Gass (An interesting paper, tracing the growth of this art from the earliest American development. The influences that have shaped it, and the accomplished men that have aided its progress are also considered). Jour Roy Inst of Brit Arch–Feb. 6. 3800 w.

4496. Hollow Building Blocks. Ed. F. Darnell (The author recommends hollow blocks throughout the building, outside walls included and gives an example. Compression tests are also given). Clay Rec–Feb. 26. 2700 w.

*4543. Saint-Front de Périgueux and the Domed Churches of Périgord and La Charente. R. Phené Spiers (Abstract of paper read before the Roy. Inst. of Brit. Arch). Arch, Lond–Feb. 21. 900 w.

*4544. Architectural Training. G. A. T. Middleton (Paper read at the meeting of the Soc. of Archs., London). Arch, Lond–Feb. 21. 4200 w.

*4589. The Conditions of Building Contracts. A. A. Hudson (Paper read before the Surveyors' Institution. The conditions to be considered are carefully discussed). Builder–Feb. 22. 3000 w.

*4622. The Tall Office Building Artistically Considered. Louis H. Sullivan (An examination of the elements, confining the attention to those conditions that, in the main, are constant in all tall office buildings). Lippincott's Mag–March. 3500 w.

4652. High Office Buildings in New York. Ill. (Brief comments on legislation regarding high buildings, with some reference to appearance, etc). Sci Am Sup–March 7. 1000 w.

4659. A Large Truss in the Waldorf Hotel Extension, New York City (An interesting piece of structural work in the shape of a great truss carrying a floor so as to leave a room free from columns. Illustrations, with description of the special methods required for the work). Eng News–March 5. 1400 w.

4669. Shrinkage of Wood (Selection from Timber Bulletin No. 10, Agricultural Dept., Division of Forestry. Illustrated). Arch & Build–March 7. 2500 w.

*4708. Released Ashlar—A Problem in Ornamentation and Building Construction' Ill. John Cotter Pelton (The paper is intended to call attention to the subject of released ashlar construction in its broad application to modern structures. The idea in the perfection of this method of construction is the minimum use of the more costly and beautiful materials, stone and marble). Jour Assn of Engng Soc–Jan. 6000 w.

*4719. The Future of American Architecture. John Stewardson (Extracts from a paper published in Lippincott's Mag). Brit Arch–Feb. 28. 2400 w.

*4720. Romanesque Architecture. Ill. Prof. Aitchison (The Fourth Royal Acad. lecture on architecture). Builder–Feb. 29. 3000 w.

*4721. The Modern Stencil and Its Application to Interior Decoration. Arthur Silver (Read at meeting of the Architectural Assn. A paper dealing with the subject fully). Arch, Lond–Feb. 28. 8000 w.

†4724. Architecture of Norway and Sweden. George W. Maher (Historical description). In Arch–Feb. 2500 w.

*4725. Cottage Design. Ill. Arthur M. Reed (A few of the qualities desirable to obtain are set forth for cottages in town, village and country, with general remarks). Ill Car & Build–Feb. 28. 4800 w.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

Influence of Magnesia in Cement.

THIS question has been one which has raised much discussion and the expression of varied opinions. The report of the committee of the German Portland cement manufacturers, reprinted in *The Scientific American Supplement* (Dec. 21), throws some light upon the subject, and we quote as follows from it:

"The majority of the committee, Dr. Schott, Herr Meyer, and Dr. Arendt, reported as follows: 'Our investigations, in part extending over a period of five years, have failed to show an injurious effect from magnesia in Portland cement, in the composition of which the magnesia replaces an equivalent amount of lime.'

"Dykerhoff, another member of the committee, could not agree with this view, his experiments having led him to a very different conclusion, a statement of which was given in a minority report, the substance of which is given below.

"Dr. Meyer described at length the experiments which led the majority of the committee to the conclusion that magnesia is a harmless ingredient in Portland cement. According to Dr. Meyer, this is always the case if the relation between the proportions of lime and magnesia, on the one hand, and silica, alumina, and iron oxid, on the other, remain normal. So long as the ratio of silica plus alumina plus iron oxid to lime plus magnesia does not exceed 2.2, the presence of magnesia up to 8 or 10 per cent. caused no harmful expansion or cracking in the cement, even after several years. Further, any considerable percentage of magnesia in the raw material makes it extremely fusible and very difficult to burn properly without melting to a glass. For this reason cements containing much magnesia are practically shut out from consideration, owing to the impossibility of their passing the standard requirements as to tensile strength. It was therefore recommended that the resolution of the committee be adopted, and that thus a number of manufacturers should be relieved from the unjust requirement that the amount of magnesia contained in Portland cement should not exceed 3½ per cent. It, however, failed in being adopted.

"Herr R. Dykerhoff then gave an account of his own experiments on this question. In these experiments the proportion of lime was purposely kept low, the ratio $SiO_2 \times Al_2O_3 \times Fe_2O_3$: CaO being 1.83. Two series of mixtures were made; in the first, magnesia was added to the mixture in various proportions up to 21 per cent.: in the second, the same amounts of magnesia were substituted for equal amounts of lime. The charges were burned to complete sintering, and all over or under burned portions were rejected. The resulting cements were tested for tensile strength with three parts sand, and for expansion, at intervals up to five years. Complete tables showing the results in detail, are given. These results may be briefly described as follows:

"1st. Magnesia added. Tensile strengths at four weeks about equal up to 18 per cent. magnesia. All showed good increase in strength up to six months, after which time the cements with 17 and 21 per cent. magnesia showed decided falling off in strength. After two years all cements with over 4 per cent. magnesia showed a decrease in strength. At the end of five years the cements with 1 to 4 per cent. magnesia showed good strength, while those with 5 to 11 per cent. were weaker, and those with 17 and 21 per cent. magnesia showed a strength of 0. One cement with 6 per cent., lightly burned and not sintered, showed no noticeable decrease in strength in five years. Tests of expansion showed that in cements with 1 to 3 per cent. magnesia the expansion was slight up to one year, then practically ceased. With 4 per cent. and over the expansion during the later periods steadily increased with increased proportions of magnesia. Actual cracking was shown by the cement with 8 per cent. magnesia at the end of five years. Cements higher in magnesia all showed cracking at earlier periods.

"2d. Magnesia, substituted for lime. Two mixtures were made, with 6 and 11 per cent. magnesia. Both showed decided falling off in strength after six months, and both showed cracking at five years and three years respectively. Another cement, containing 18 per cent. magnesia, was lightly burned and not sintered, and showed steadily increasing strength and freedom from cracking up to five years.

From these experiments Dykerhoff concludes that the harmful effect of magnesia in Portland cement is due to the dense condition which it assumes at the sintering temperature, in consequence of which the magnesia becomes hydrated only very slowly, and during hydration shows marked expansion. In light burned cements, on the other hand, like the American natural rock cements, the magnesia is in a far less dense condition, and readily becomes hydrated without injurious expansion. This view was confirmed by the addition of strongly sintered magnesia, separately prepared, to a cement nearly free from magnesia. With 10 per cent. sintered magnesia the strength was 0, and cracking appeared after two years. With 20 per cent. the cement disintegrated in four weeks. Light burned magnesia (magnesia usta) added in the same proportions produced no injurious effect. Dykerhoff summarizes his conclusions as follows:

"'The presence of magnesia up to 3 per cent. in Portland cement produces no change in its properties. From 4 per cent. on, however, magnesia, if sintered, whether added or substituted for part of the lime, has an injurious effect, producing increased expansion and decreased strength after long periods. This injurious effect is the stronger, the higher the percentage of magnesia. If the cement is not sintered, however, a high proportion of magnesia, even 18 per cent., may be harmless.'

"To make matters somewhat easier for manufacturers using magnesian material, he recommended that the allowable limit of magnesia be placed at 5 per cent. instead of 3½ per cent."

Strength of Arches.

ANOTHER valuable contribution to engineering data comes to us through *Engineering* (London, Feb. 21), from which we extract the following:

"An extremely valuable and interesting series of experiments have been carried out by the Austrian Association of Engineers and Architects on model arches. A sum upwards of £4,000 was expended, though the work was to a large extent done gratuitously." Experiments were made on arches of 4.42 ft., 8.85 ft., 32 ft. 9.7 in., 74.5 ft. and a steel girder of 5.9 ft. span. The results of experiments on arches of 8.85 ft., span are given in the accompanying table. The load was distributed over one half the span only.

"In no case was the deflection proportional to the load, though in the case of 6 it was nearly so. In all these cases the abutments consisted of I-beams efficiently tied together. Some experiments were next made on a concrete arch of 13.3 ft. span, 16.1 in. rise, and 3.94 in. thick at the crown. This arch sprang from regular skewbacks, and failed when a load of 790 lbs. per square foot was distributed over one half the span from abutment to crown. The deflection of the crown at rupture was about ¼ in., but a point midway between springing and crown had deflected ⅝ in. before failure occurred. A Monier arch of similar dimensions, tested in the same manner, failed under a load of 872 lbs. per square foot, but both arches showed cracks at the same load,—*viz.*, 614 lbs. per square foot. The deflection of the Monier arch at the crown when failure occurred was ¾ in., and at a point half-way between abutment and crown $\frac{7}{16}$ in. A Melan arch was next tried. In this construction steel arch ribs of I-section are imbedded in the concrete, being spaced in the present instance 3 ft. 4 in. apart. The I-beams in question were 3.15 in. deep, and the concrete filling was of the same thickness, being flush with their upper and lower flanges. The span was 13.1 ft., and the rise 11.4 in. The arch was loaded on one side only, and failed when 3,370 lbs. per square foot was reached, breaking in three pieces under this load. The first cracks were observed under a load of 3,120 lbs. per square foot on the loaded side."

TABLE SHOWING RESULTS OF EXPERIMENTS ON ARCHES.

Number.	Material.	Span.	Thickness at Crown.	Rise.	Weight of Arch per Sq. Ft.	Breaking Load, Pounds per Sq. Ft on Half Span.	Vertical Deflection at Crown under Load. At Rupture	Vertical Deflection at Crown under Load. Of 400 lbs per Sq. Ft.
		ft.	in	in.	lb.	lb.	in.	in.
1	Rammed concrete............	8.85	3.35	9.05	286	1127	.94	.34
2	Ring of cement reinforced with wire netting (Monier's system)	....	1.95	10.23	230	1217	1.01	.34
3	Ring of cement (Monier's system) levelled up over the haunches with concrete.	....	2.17	10.23	505	1320	1.22	.18
4	Arch of ordinary bricks	....	5.51	9.84	248	883	1.87	.77
5	" Hönel bricks	....	3.94	5 31	166	491	1.53	1.45
6	" corrugated iron.......	....	....	9.84	14	973	1.06	.45
7	" " " with L iron riveted along it at the springing.........	....	...	....	20	1100	1 14	.47

The tests made on five 74.5 ft.-span arches, having a rise of about one fifth, loaded to destruction, are very important.

"Each arch was 6.65 ft. wide. A platform supported on six sets of columns, the feet of which rested directly on the extrados of the arch, extended in each case from one abutment to the crown, and the testing was effected by piling rails on this platform. The first experiments were made upon an arch of cut stone, and on one of brick. The stone used was a fairly hard limestone of excellent quality. The voussoirs of both arches were 1.97 ft. thick at the crown, and 3.6 ft. deep at the springings. The mortar used was mixed in the proportion of 5 cwt. of Portland cement to 35 ft. of clean sand. The stone arch gave way when the load piled on the platform reached an amount equivalent to 1.99 tons per foot run, and the brick arch when the load reached 1.81 tons per foot run. Up to the point of rupture the stone arch gave no signs of incipient failure, but, in the case of the brick arch, cracks declared themselves previously, which were apparently caused by the failure of the mortar, the bricks themselves being intact.

"After removing the ruins, a third arch of similar span and rise was constructed between the same abutments, the material being rammed concrete. The thickness of the arch ring was, however, uniform, being 2.3 ft. The body of the arch consisted of 1 part Portland cement, 2 parts broken stone, 3 parts gravel, and 3 of sand, but for the intrados and extrados a higher quality of concrete was used, that for the former consisting of 1 part Portland cement, ½ part broken stone, ½ part gravel, and 1 part sand, whilst the latter consisted of 1 part Portland cement, 1½ parts broken stone, 1½ parts gravel, and 2 parts sand. The total quantity of concrete in the ring was about 50 cubic yards. Two months after completion the centers were removed, during which time the arch was protected from the sun and frequently watered. The testing commenced three weeks after the centers had been removed. Failure took place under a load equivalent to 2.24 tons per foot run on the loaded half of the arch.

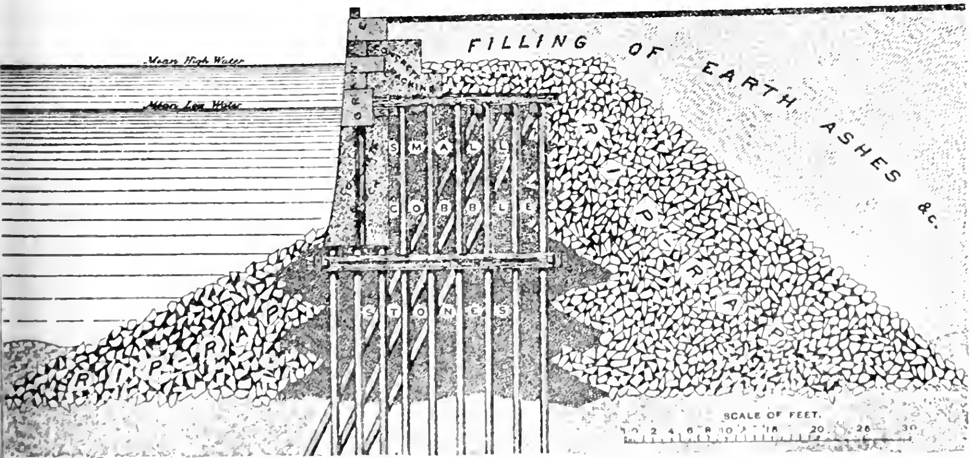
"The next arch to be tested was constructed on the Monier system, the span and rise being as before, whilst the thickness of the ring was 1.97 ft. at the springings and 1.15 ft. at the crown. The concrete used consisted of 3 parts of river sand to 1 part of slow-setting Portland cement. The centers were removed at the end of two months, and arrangements made for testing. Failure took place under a load equivalent to 3.09 tons per foot run of the loaded half. Great difficulty was found in removing the ruins. The metal reinforcement was found intact, having bent, but not broken, at the points of failure.

"The final experiments were made upon a steel arch of the same rise and span as the four preceding ones. This consisted of two steel ribs fixed at 5.9 ft. centers and rigidly braced together. Each rib was of girder section 12.6 in. deep. The total weight of the steel work was 15.6 tons. On testing with a load of 82¼ tons distributed over half the arch, no serious deformation was observed. The load was then removed, and on the next day 158 tons of rails were piled up on the loaded side. The deflection was then considerable, but agreed well with the calculated result. This load was left in place throughout one night, after which rails were piled on the side not previously loaded till a total of 175 tons was reached. The deflection was still further increased, but not a single rivet yielded. The load was then removed, and the experiments terminated. From their experiments the committee concluded that, in arches of large span, the calculations may safely be based upon the theory of the elastic arch. With a view to distributing the load as much as possible in the case of masonry arches, the extrados should be covered with a layer of ballast, which should be at least 3 ft. thick in the case of railway bridges. The safe crushing load on such arches may range from one-tenth to one-fourth the ultimate resistance of the material."

Standard Bulkhead Walls.

THE New York city board of consulting engineers recently presented a report to the commissioners of the department of docks on the construction of bulkhead walls on mud- and on rock-bottoms. *The Railroad Gazette* (Feb. 21) prints the part of the report referring to mud-bottom construction:

"As the bulkhead wall is a retaining wall, which has to resist the horizontal thrust of the earth-filling behind it, and both that earth-filling and the wall itself are floated in mud, the problem of providing a permanent construction becomes a very unusual one. To build a retaining wall on a solid foundation is a simple problem. To build a wall to carry vertical weight only, on a soft foundation, is more difficult. To float a wall in mud, when that wall must also take a horizontal thrust, is a problem which can only be solved by care and experience, no formula or mathematical rules being available. The wall, as now built, is a satisfactory solution of this problem. Your board believes it to be a unique construction, one which is worthy of the most careful study, and which deserves the strongest commendation. The masonry wall is carried on piles, and so floated in the mud. It, however, is not the real retaining wall, but simply a substantial facing, which gives a permanent finish of convenient shape. The same pile foun-



Cross-Section of Bulkhead Wall on Mud Bottom—New York City, Department of Docks.

dation extends back of the wall, and is filled in and around with a mass of rip-rap, which distributes the weight over a large area of the mud, while the whole is braced up by piles driven at an angle. The real retaining wall is the combined mass of rip-rap, masonry, and piles, the whole floated in such a mass of mud that it is practically consolidated into one mass.

"The fact that this wall has settled in places is exactly what was to be expected; it is no proof of weakness or instability; the wall is simply the finished edge of the 250-ft. marginal way, and the whole has settled together; so long as it performs its duty of furnishing practically a vertical surface on the water-side of this way, it is perfectly successful. The function of this wall is that of a practical tool; it is not a monument; though handsome, it is not intended for ornament; it performs none of the functions of the foundation of a building. Its development has been gradual, and it is probable that future improvements will be made; but this board does not hesitate to say that it considers this wall a solution of a very difficult problem, which is remarkable for its originality and the excellence of its results."

Proposed Improvement in the Service of Night Watchmen.

AT a meeting of the officers of the Hartford Fire Insurance Company, Mr. C. F. Simonson, general inspector, delivered an address, in which he showed that the physical nature of night watchmen is not equal to the demands upon it. He cites a number of cases where watchmen have fallen asleep; where they fall asleep for but a short time, and then tamper with the time-clock to cover their negligence; where watchmen have been overtaken, while asleep, by flames; and he says that it is not surprising that, with fourteen hours of watchful monotonous duty and ten hours for eating and sleeping, a watchman sometimes lapses. To quote his own words, published in the *Engineering News* (Feb. 13): "It is evident that watchmen are of little benefit in a building at night, and that even the most perfect watch service will not compel a man to stay awake when nature demands sleep. It is cruel and inhuman for us to exact such a service from any man, and in my opinion earnest effort should be made to lighten their burden by advocating the following plan:

"Select two men capable and fit to be watchmen, sweepers, or helpers; let one begin his shop-work at noon; when the factory closes at night, he takes a round, until satisfied that everything is all right and in proper shape, then eats his supper, which he carries with him, and enters into his regular rounds of watching. He watches until 11.30, reaching home before midnight. The second man relieves him at that time, and watches until 6 A. M., when he eats his breakfast, starts the fire, and opens the factory for employees at 7. Having had breakfast, and the factory open, he is ready to go to his shop-work until noon, when he goes home and returns at 11:30 that night. In this way the expense would be no greater than employing a sweeper or helper during the day and a watchman at night, and each would have one-half day and one-half night at home. It is plain to any one that a man with these hours at home could get the requisite amount of sleep. Change about could be had each week, so that the man who had the first half of the night to watch one week could have the second half the next week and *vice versa*.

"A man that works nights and sleeps days becomes a machine instead of a live man, and it is a common thing to find buildings badly on fire with the watchman taken out suffocated and nearly dead; and in all the big fires in Chicago at night watchmen have been employed. In the Pinkerton watch service the men go on at 7 P. M. and come off at 10; go on at 1 A.M. and off at five. In the watch-tower fire service, from which an average of four hundred alarms are sent out each year, the men are relieved every two hours, so careful are they that they must not sleep. The system has been tried for the past two years by Charles F. Elms Engineering Works and Lyon and Healy Organ Factory of Chicago, who recommend it highly and say that nothing could induce them to change back to the old system. No man can work continuously fourteen hours at night and be fit for work of any kind, much less that of watching and guarding millions upon millions of property values, in which, it may be, the safety of cities is involved; and I earnestly recommend that this system of watching be proposed, and its adoption secured wherever possible."

Shaft Sinking by Congelation.

WHERE shafts or tunnels are run through strata containing water under pressure, the usual methods of tubbing are very expensive, and the method of freezing the water at the place of excavation has been devised, and is known as the Poetsch process. After some expensive experience in sinking a 78½ m. shaft at a cost of £220 per yard, which involved tubbing and the pumping of 9,000 gallons of water per minute, the engineers of the Auzin Mining Co., adopted the freezing process for sinking two shafts to the coal measures at Vicq in the valley of the Scheldt. The operation and cost of this undertaking are described by Messrs. Saclier and Waymel in the *Bulletin de la Société de l'Industrie Mineral*, and translated in *The Colliery Guardian* (Dec. 13). We abstract as follows:

"The two pits are of unequal size, a smaller one of 3.65 m. diameter being intended for the accessory work of pumping, ventilation, and traveling, while the larger one of 5 m. (16½ ft.) in the clear is to be fitted with cages carrying eight tubs and capable of raising 300,000 tons of coal per annum."

The strata are water-bearing to a depth of 91 m. below the surface. The first level encountered gave a flow equal to 2,700 gals. per hour, while the water in the lower level was under pressure sufficient to make it rise 2½ ft. above the ground. The method of procedure is thus described:

"The borings intended to receive the circulating pipes for the freezing process, which were done by contract by Messrs. Hulster Brothers, are thirty-six in number, of a total length of 3,312 m., twenty of them being arranged in a circle of 6.5 m. diameter around the larger pit, and sixteen on a 5.10 m. circle for the smaller one, all being of the same depth, 91 m. The freezing circuits, which are probably the most important elements in the whole plant, consist of a series of steel pipes, of unequal diameters, the smaller ones, of 30 mm. diameter and 4 mm. thickness of metal, being placed concentrically within the larger ones, which are 116 mm. bore and 7 mm. thick, each series being connected by goose neck to its own ring main. The chilled fluid from the freezing machine passes from one of the rings down the inner tubes, and returns through the outer ones to the surface and back to the refrigerator through the other."

After describing the compressors and other apparatus, the authors state that "the total quantity of ammonia in use in the apparatus was 732 kilogs., which was supplied by Mr. J. Peintre, of Verviers, at the price of 4.25 fr. per kilograme. The calcium chlorid solution in circulation measured 62 cubic metres, and contained 25 tons of the dry salt, also supplied by Mr. Peintre at 150 fr. per ton. The density of the solution was 1.25, corresponding to a specific heat of 0.68 per kilograme or 0.85 per liter."

"The cost of the sinking is given in very full detail in the paper, the total amount having been about £28,400, or £120 per meter, the different items being summarized in the following table:—

	Per cent.	Total. Fr.	Per meter. Fr.
Patentee's royalty	4.6	132,760.00	139.20
Temporary plant	2.7	19.582.40	83.25
Borings for freezing tubes....	10.4	73.673.03	313.10
Freezing plant...	35.0	248,765.56	1,057.20
Measuring apparatus....	0.3	1,898.68	8.10
Freezing........	4.7	33,030 95	140.40
Sinking and tubbing......	40.5	287,454.77	1,221.65
Carriage........	0.6	4.562.00	19.40
Tools...........	0.7	5,257.00	22.35
Sundries	0.4	2,865 00	12 15
Total.......	99.9	709,850.39	3,016.80

"The center of the pit was kept as warm as possible, and the temperature never was less than—1.2 deg. Cent. In the chalk a depth of 2½ to 2 m. per day was gone through, though this decreased to 30 to 50 mm. in the harder silicious rock.

"The items specially chargeable to the freezing operations are:

	Fr.
Patent rights	32,760.90
Boring	73,763.03
Erecting	14,084.72
Measuring instruments	1,899.68
Freezing cost	33,030.95
Total	155,448.38

"This sum, corresponding to about 660 fr. per meter, represents all that would have been available for bearing the cost of pumping, temporary lining, and the numerous other charges incidental to sinking in heavily-watered ground, supposing the ordinary method of sinking had been adopted. The coal burnt in supplying steam for the compression was 2,191 tons between the 28th of May and the 28th of December, which, allowing for short time and stoppages, corresponds to about 200 working days. The work developed corresponds to a total removal of 851,656,686 calories, or 461,353,162 calories for the larger and 390,303,706 calories from the smaller pit. About 20 per cent. of the cooling effect was lost at the surface, owing to the distance of the machines from the pits.

"Supposing the whole of the plant to be charged to the single use, its subsequent employment in future sinkings would benefit them to the extent of about 1000 fr. per meter, so that the work could be done for about 2,000 fr. per meter."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

Bridges.

*4148. Van Buren Street Rolling Lift Bridge, Chicago, Ills. Ill. Warren R. Roberts (A thorough description with full structural details). Jour Assn of Eng Soc–Dec. 11500 w.

4263. A Railway Bridge and Building Department. Onward Bates (A well written article examining into the factors which are conducive to the highest efficiency). Ry Rev–Feb. 15. 2700 w.

4342. An Italian Drawbridge (The central span is a lifting leaf 41 ft. 7 in. long and 30 ft. 5 in. wide, operated by hydraulic mechanism). Eng News–Feb. 20. 450 w.

4356 The New York Central Four-track Drawbridge Over the Harlem River (Illustrated description of probably the heaviest railroad drawbridge in the world; it is 400 ft. long, with a depth at center of 64 ft., and weighs 2500 tons. A detail is given of the track-locking apparatus). R R Gaz–Feb. 21. 2700 w.

4393. Proposed Bascule Bridge. Ill. (A counterbalanced swing bridge having a clear opening of 150 ft. and fitted with a novel counterbalance. A subway is provided for pedestrians when the bridge is up). Eng Rec–Feb. 22. 200 w.

4481. The 840-ft. Steel Arch Bridge at Niagara (A description with detailed drawings of the abutments for a bridge to be built over the Niagara gorge, after the designs of Mr. L. L. Buck, with a general account and foundation details, and an ideal view). R R Gaz–Feb. 28. 2000 w.

†4522. The New Papaghni Bridge on the Madras Railway. Harry James Thompson (Paper read before the Inst. of Civ. Engs. The piers consist of two 12-ft. cast iron cylinders, sunk through 60 feet of sand, clay, silt and boulders to rock bottom, and filled with concrete and masonry. The principal cost items are included). Ind & East Eng–Feb. 1. 1600 w.

*4556. Experiments on Arches (An extremely valuable and interesting series of experiments carried out by the Austrian Assn. of Engs. & Archs. on model arches of spans ranging from 4 42 ft. up to 75.4 ft). Engng–Feb. 21. 2000 w.

4648. The Monier Arch Bridge at Draulitten, Germany (Description abstracted from the *Centralblatt der Bauverwaltung*. The arch has a span of 88 ft. and a rise of 21 ft., and bore a test load of 164 lbs. per sq. ft. satisfactorily). Eng Rec–March 7. 1000 w.

Canals, Rivers and Harbors.

*4104. Barry Docks (A well illustrated account of improvements in and about Bristol Channel at Barry. The Lady Windsor lock is fully described). Engng–Jan. 31. 4500 w.

*4109. Cost of Ship Canals. Henry E. P. Cottrell (A table showing the actual cost of excavation on ship canals and the proportion it bears to that of accessory and contingent works. Communicated by the writer as an addenda to his article in the issue of Nov. 29). Engng–Jan. 31. 500 w.

4183. The North River Water Front (A valuable report by the Board of Consulting Engineers, appointed by the Commissioners of the Dept. of Docks, to investigate plans for improving the western river front of the city). R R Gaz-Feb. 14. Serial. 1st part. 3200 w.

*4213. Canals and Navigable Rivers. L. B. Wells (Abstract of a paper read before the Manchester Geog. Soc. An examination into the causes for high rates on inland transportation in England, with valuable statistics). Ind & Ir-Feb. 7. Serial. 1st part. 800 w.

4345. Concrete Locks on the Coosa River, Alabama. Ill. Charles Firth (These government improvements will open up 776 miles of river waterway to steamboats. The work was carried out by U. S. engineers and is fully described). Eng News-Feb. 20. 1700 w.

4348. A Combined Cable Excavator and Conveyor (A simple form of cableway employed in excavating the Suwanee Canal, Ga.; it is fully described and illustrated). Eng News-Feb. 20. 2400 w.

*4384. Canals and Navigable Rivers. L. B. Wells (Paper read before the Manchester Geog. Soc. on inland transportation). Eng, Lond-Feb. 14. 1400 w.

*4385. River Parrett Improvement Scheme. H. G. Foster Barham (A canal scheme is discouraged and the river improvement thoroughly discussed from a practical standpoint. The report is thorough and detailed). Eng, Lond-Feb. 14. 7000 w.

4480. The Mississippi River Improvement (A reply of Mr J. A. Ockerson to an article by Prof. Johnson criticising the work of the Mississippi River Commission). R R Gaz-Feb. 28. 2000 w.

*4545. The Mexican Drainage Canal. F.H. Cheesewright (Read at a meeting of the Soc. of Arts. An interesting historical account of this great work which it is prophesied will make Mexico the most healthy city in the world). Arch, Lond-Feb. 21. 4400 w.

*4560. The Two New Docks at Portsmouth (The method of construction is fully described and illustrated by drawings. The two docks are each 563 ft. 6 in. long, 120 ft. wide, and 43 ft. 6 in. deep). Eng, Lond-Feb. 21. 3300 w.

†4569. Notes on Dry Docks of the Great Lakes. A. V. Powell (After some historical notes, the author proceeds to describe the construction of the Chicago Shipbuilding Co.'s dry dock in detail, giving many views to illustrate). Jour of W Soc of Engs-Jan. 3500 w.

†4571. Lakes and Atlantic Waterway (Memorandum in regard to certain profiles designed to exhibit the ruling points, and accompanied by four profile sheets. Compiled by the publication committee from the records of the sanitary district of Chicago). Jour W Soc of Engs-Jan. 1400 w.

4658. The Mississippi River Navigation Improvement. J. A. Ockerson (A communication in which the writer corrects some misstatements in a previous number, with a reply from J. B. Johnson). Eng News-March 5. 3800 w.

Hydraulics.

☞4187. The Nevada County Electric Power Company's Dam in the South Yuba River. Ill. (The dam is forty feet deep, 28 ft. high and 206 ft. long; it is built of timber cribbing bolted to the rock bottom and weighted with 9000 tons of broken granite. Pelton wheels working under 206 ft. head, drive two 300 K. W. Stanley transformers, furnishing light and power to Grass Valley and Nevada City and adjacent mines). Min & Sci Pr-Feb. 8. 500 w.

4303. Flow of Water in a 48-inch Pipe. Rudolph Hering (A discussion of Mr. FitzGerald's paper before the Am. Soc. of Civ. Engs., commending the use of the Chézy formula, $v=c\sqrt{rs}$, and insisting that full description of the conditions to which it is applicable should accompany the presentation of any formula). Eng Rec-Feb. 15. 1800 w.

4344. The Friction in Several Pumping Mains. Freeman C. Coffin (A paper read before the New England Water Works Assn. A tabular statement, with diagram, is given of five different installations of simple and compound pipe relative to the carrying capacity, computed and actual friction. The comparison of computed friction by different formulæ is interesting). Eng News-Feb. 20. 2200 w.

4347. Report on the Yield of the Pequannock Watershed, New Jersey (Mr. C. C. Vermeule recommends an increase of storage capacity and shows at length why he does so). Eng News-Feb. 20. 3900 w.

†4570. New Experimental Data for Flow Over a Broad Crest Dam. Ill. Thomas T. Johnston and Ernest L. Cooley (The method of conducting the field observations, and the results obtained are given in full with tabulated observations. The paper was followed by a theoretical discussion by Mr. Thos. T. Johnston). Jour of W Soc of Engs-Jan. 6000 w.

4649. Method for Approximate Gauging of Rivers. C. E. Grunsky (Extract from a report to California Commissioner of Public Works. A method for computing discharge graphically by means of curves). Eng Rec-March 7. 900 w.

†4457. Ways and Means in Arid America. William E. Smythe (An interesting illustrated account of the rise of irrigation on the plains, and its achievements). Cent Mag-March. 6800 w.

*4532. Punjab Irrigation, Ancient and Modern. James Broadwood Lyall (An exceedingly interesting paper read before the Indian section, Feb. 13, from which many valuable hints may be derived by modern engineers in irrigation. Prefaced by remarks from the chairman of the meeting and followed by a discussion). Jour Soc of Arts-Feb. 21. 15500 w.

Miscellany.

*4095. Cast Iron Segments for Railway and Other Tunnels. Evelyn G. Carey (Paper read before the Inst. of Engs. and Shipbuilders. The method of casting and joining the segments is described and fully illustrated while a number of cases are given to show variation in form due to different requirements). Ind & Ir-Jan. 31. 5000 w.

*4102. London Fires and the Brigade (A few notes on London methods of fire prevention and extinguishing). Eng, Lond–Jan. 31. 1100 w.

*4110. Checking Engineering Calculations. A. Hanssen (A method applicable to tables where the index column differs by constant differences). Engng–Jan. 31. 2700 w.

4149. The Engineer of To-day. St. George Boswell (A paper read before the Applied Science Graduates Society of McGill Univ. The writer includes under the title all branches of engineering, excepting military engineering, and explains the qualifications which are necessary to an engineer, that he may satisfactorily perform the various duties incident to his profession). Can Eng-Feb. 4000 w.

4186. American Portland Cement Tests (A time record, from 1 day to 5 years, of tests on cement entering into the construction of five pieces of engineering work, using an aggregate of 310,000 barrels of cement). R R Gaz–Feb. 14. 400 w.

4217. A Proposed Improvement in Arrangement of Service of Night Watchmen. C. F. Simonson (From an address delivered at a meeting of officers and special agents of the Hartford Fire Insurance Company. The author is Gen. Inspector of the company. He suggests the employment of two watchmen in order to prevent the carelessness of one man alone). Eng News–Feb. 13. 1500 w.

4218. The Code of Engineering Ethics Adopted by the Canadian Society of Civil Engineers (Reprint of the full text of the code without comment). Eng News – Feb. 13. 1200 w.

4233. Drying Clay Goods by Hot Floor System. C. J. Holman (Two types of drying floors are described; one heated by hot air; the other by exhaust steam). Clay Rec–Feb. 12. 1300 w.

4234. Farm Drainage. John Cownie (A scheme is proposed by which the extensive Iowa swamp lands may be tile drained). Clay Rec–Feb. 12. 1800 w.

4358. The Bulkhead Walls of New York. (Standard sections of bulkhead retaining walls built on mud and on rock bottoms. The Board of Construction Engineers think it an excellent and satisfactory solution of a very difficult problem). R R Gaz–Feb. 21. 400 w.

*4383. Storage of Coal in Hoppers at Battersea (A detailed description of hoppers and steam crane with drawings). Eng, Lond–Feb. 14. 1100 w.

4442.—$1.50. The Strength of Pillars. —An Analysis Leopold Eidlitz (The question examined in this paper is mainly what is the maximum strain in pillars compressed endwise in the center of resistance by weights less than the breaking weights, or by weights not applied in the center of resistance. Diagrams and tables are presented and formulæ deduced and discussed). Am Soc of Civ Eng-Feb. 8500 w.

*4462. The Manufacture of Concrete. Ross F. Tucker (The importance of mixing considered as essential to success as the materials used). Br Build–Feb. 1000 w.

4495. Why I am Attending the Clay-workers' School. E. E. Gorton (Some interesting remarks on this new departure in technical education). Clay Rec–Feb. 26. 2000 w.

4497. The Preparation of Clay. W. A. Eudaly (An interesting paper, by a specialist, upon the properties and treatment of common clays). Clay Rec–Feb. 26. 2200 w.

4538. The Painting of Iron Surfaces. J. Spennrath (Translated by Henry Szlapka from the *Deutsche Bauzeitung* Alkalies or acids affect paints very strongly. The paper deals with various rust preventive methods in detail and is throughout very instructive). Am Gas Lgt Jour–March 2. 2800 w.

4564. Woodiline for Timber Preservation (Some of the advantages of tie preservation are spoken of and particular mention is made of the effects of woodiline, and also of its properties). Eng, Lond–Feb. 29. 1600 w.

†4572. Cement and Its Uses. Alfred Noble (The writer's notes include many facts and much data of use to cement consumers. A large number of cement tests accompany the communication). Jour W Soc of Engs–Jan. 4400 w.

†4573. Notes on Cement. Ira O. Baker (Influence of water and sand on the quality of cement, and the effect of different methods of moulding and treatment). Jour W Soc of Engs–Jan. 800 w.

†4574. Qualifications of Portland Cement. J. W. Dickinson. Jour W Soc of Engs–Jan. 1200 w.

†4575. Cement and Cement Mortars. Thomas T. Johnson (The author gives the reasons for the failure of cement under ten heads, and appends the results of numerous tests). Jour W Soc of Engs–Jan. 2800 w.

†4576. Experiments on the Elasticity of Concrete. C. Bach (*Zeitschrift des Vereines Deutscher Ingenieure.* The cement was compressed by varying loads and the percentage contraction noted. This was as much as 1.3%). Jour W Soc of Engs–Jan. 800 w.

4642. A French Lighthouse Tower of Concrete (A description with illustrations of a lighthouse tower recently built at Lorient, in the Bay of Biscay. The structure is entirely of concrete). R R Gaz–March 6. 2500 w.

4656. Requirements for Tensile Strength in Cement Specifications. J. M. Porter (The author shows that the personal equation of the person testing the cement enters into the test so largely that the results are not at all reliable. Nine samples were sent to different laboratories whose averaged reports ranged from 75 to 247 pounds. Testing requirements are suggested, among which is abolishing the use of testing machines). Eng News–March 5. 2800 w.

*4690. The Demolition of a Mill Chimney at Manchester (The chimney, which was over 11-ft. in diameter, and 270 ft. high was underpinned on one side and these props burned out, resulting in the collapse of the structure). Eng, Lond–Feb. 28. 1200 w.

Advances in Heating and Ventilating Tall Office-Buildings.

EXISTING defects in the heating and ventilation of tall office-buildings have been frequently alluded to in these pages. The imperative need for something better has directed the attention of able engineers to the subject. That they will ultimately succeed in adding to the other advantages of this modern type of architecture the further merit that such buildings shall, at all times and seasons, be wholesome and comfortable places for the transaction of business seems certain, in view of some of the recent work done in New York and other American cities.

A notable example of these improved installations is one designed by Mr. Alfred R. Wolf, of New York city,—an engineer who has for a considerable period made a specialty of designing heating and ventilating apparatus for tall office-buildings, and who has successfully met and surmounted many of the difficulties that attend the satisfactory solution of a very difficult problem.

The installation referred to is in the building of the American Surety Company, in New York city. A description of it, with plans and illustrations of details, is presented in the *Engineering Record* (March 7). Some of the leading features are described in the following abstract.

A combination of direct and indirect methods has been adopted. There are twenty-one stories in the building. Up to and including the seventh story, the indirect method is used. For the remaining fourteen stories the direct method is employed. The fourteen upper floors, under such conditions, will doubtless be no worse or better in respect of heating and ventilation than a fourteen-story building having the same floor plan and heated wholly by the direct method. The seven stories heated by the indirect method will be far superior in wholesomeness and comfort to the rooms of most tall office-buildings.

Forced circulation is maintained through the indirect heating and ventilating system. "Each room is provided with several vent registers opening into ducts carried up to the roof alongside of the interior columns near the stairway or alongside of the columns in outside walls. As the air-supply is only warmed to about the temperature of the rooms, a direct radiator is placed under every window in the building to take care of the transmission of heat from the window, and to counteract any down draft from external pressure. The first seven stories are supplied with fresh air for the purpose of ventilation by means of a blower. This air can be heated to any desired degree, preferably about room temperature in the winter-time, while an abundant supply of air of external temperature is furnished in the summer months.

"All of the rooms above the seventh floor are heated entirely by direct radiation. The heating and lighting plants and their accessories occupy about two-thirds of the basement, while the remainder, which is on the Pine street side of the building, is occupied by a bank. To begin with the details of the ventilating plant, we find that the air-supply is drawn into a covered chamber in the south-east corner of the building, and in this is located an 8-foot Sturtevant blower capable of furnishing about 35,000 cubic feet of air per minute. The fan is driven by a belt from a 20 horse-power ideal engine. Beyond the fan is a nest of heating coils containing 2,050 square feet of surface, composed of 7-foot two-row sections arranged in three groups with 1¼-inch pipes 8 feet high above the bases. The heater is provided with a by-pass controlled by a mixing damper operated by a thermostat placed in the duct leading from the blower. Between the fan in the blower and the heater two branch ducts, one 24 × 18 inches and the other 14 × 18 inches in size, take their origin and supply cold air to the boiler- and engine-rooms; the ducts are of sufficient size to change the air in these rooms once in every six minutes. The main duct from the heater is 80 × 34 inches in size. It branches into a number of smaller ducts, which, bending with long, easy curves, supply the vertical flue. It was specified that the inside radius of all bends should not be less than the width of the duct. Generally speaking, the vertical flues have a depth of 8 inches and a width depending upon the amount of air they are to carry. One 20 × 30-inch duct supplies a nest of entirely independent flues, each leading to a different floor of the building. The designer of the plant lays considerable stress upon the increased value of this subdivided system over the method of employing one large fresh-air shaft supplying horizontal ducts branching to each floor. It is said that a much more uniform distribution can be obtained with individual ducts."

The vertical flues are largely carried up inside of the exterior columns, through which also the risers are run. These flues are of No. 24 galvanized iron, with fronts cut away. "The edges are bent outward into a lip to receive a galvanized-iron front. Angles are doweled into the fireproofing at the sides of the opening, and to the angles are screwed moveable cast-iron panels reaching from the floor to the ceiling. These panels may be removed, and, after taking off the front of the duct, the riser lines will be accessible. The vertical flues have at their base a curved sheet-iron deflector, to avoid the friction when the air turns upward from the duct into the flue. Each warm-air flue has two register boxes, one about 18 inches and the other about 8 feet from the floor. To prevent the register boxes from being injured or put out of shape while the masonry was being put in, each was fitted with boards of 1½-inch stuff containing numerous 1½-inch holes, so that it might at the same time act the part of a register for temporary heating of the building. A top and bottom vent register is provided for each vent flue."

In some instances hot-air flues are continued higher than the floor which they supply with air, the portions above this being used for ventilating flues. In such cases the part of the flue above the warm-air register is separated from the lower part by a partition. "As far as possible, the riser and return lines are carried up through the vent flues, and, as these pipes are not covered, the heat from them serves to create an upward draft in the flues. All of the vent flues from the first to the seventh floor are run independently up to the level of the ninth floor, where each group is drawn together into one flue. All vent flues extend up above the roof, and are provided with suitable protecting caps, except the vent flues in the shaft surrounding the smoke-stack. These extend only to the level of the eighth floor, where they combine into one flue.

The toilet-rooms are ventilated by a separate system of flues leading to the roof, and the a.: in them is exhausted by a Blackman fan discharging through a copper elbow looking upward. The vent flues containing the riser lines are provided with elliptical openings between the ceilings and floors for branches to radiators. This allows for the expansion and contraction of the risers, and, as the flooring is of solid fireproof construction, there is no chance for any leakage from the flues at the openings between the ceilings and floors for branches to radiators. Each horizontal supply and return pipe to a radiator is inclosed in a sleeve of No. 24 gage galvanized iron.

"Each riser line is about 300 feet long, and each line was anchored at points 75 feet from the top and bottom, while, midway between, an expansion joint consisting of a return bend or loop about 8 feet long was placed. Some interesting tests were made on joints of this character by Mr. Wolf and the contractor, and it was found that, with a 4-foot bend, a deflection of 1¼ inches could be produced without introducing a permanent set on the piping; but it required a terrific strain, it is said, to produce this amount of motion in the loop. With an 8-foot return bend a motion of 2½ inches was produced, and this was the size selected."

The article affords a fine study in means and methods of surmounting the difficulties in the heating of tall buildings.

The Use of Disinfectants and Antiseptics.

In a paper "On Disinfection," written by the celebrated bacteriologist, Koch, he intimated that disinfecting agents commonly regarded as inefficient might become sufficiently active, if used at a higher temperature; and he suggested investigation into the effects of temperature upon the activity of substances known to possess antiseptic properties. In 1889 Professor Scalji of Rome published results of experiments upon increase of antiseptic effect in corrosive sublimate through increase of temperature in a weak solution of that salt. These facts, with allusions to results of further experiments by Behring and Heider, are noted by A. G. Young, M.D., secretary of the Maine State board of health, in *Journal of Medicine and Science*, and have been reprinted in *The Sanitarian* for January. The following are some of the results of Heider's experiments as given by Dr. Young. These experiments were directed to the effect of the disinfectants upon anthrax spores.

"Carbolic acid, 5 per cent. solution, at ordinary room temperature, not destroyed in from thirty to forty days; at 40° C. (104° F.), four hours; at 55° C. (131° F.), from three-quarters to two hours; at 75°, C. (167° F.), from three to fifteen minutes.

"Pure carbolic acid and sulphuric acid, equal parts of each by weight, 5 per cent. solution, at 40°, in two hours; at 55°, in thirty minutes; at 75°, in one minute.

"Pure cresol and sulphuric acid, equal parts of each, 5 per cent. solution at 40,° in one hour; at 55°, in five minutes.

"Lysol, 5 per cent., at 60° C. (140° F.), sterilization not effected in two hours; at 80° C. (176° F.), sterilization complete in five minutes.

"Sulphuric acid, 1 per cent., at ordinary temperatures, sterilization not effected in seven hours; at 75° C., sterilization in seventy minutes.

"Caustic potash, 5 per cent. solution, at temperature of room, failed to sterilize in eight to ten hours; at 55° C., spores destroyed in three-fourths to two hours; at 75° C., in two to ten minutes.

"Hot water at 70° C. (158° F.), in eight to nine hours; at 85° C. (185° F.), in forty to forty-five minutes; at 95° C. (203° F.), in fifteen minutes."

Dr. Young assigns "several" explanations of the reason why warm solutions of disinfectants show a more energetic germicidal action than cold solutions. One is the well-known fact that the intensity of chemical action increases with increasing temperature; another is that moderately-elevated temperatures favor the functional activity of bacterial life, and therefore the rapidity with which poisons are absorbed. But, when we have to do with sporeless bacteria,—and that is the case in nearly all of the real work of disinfection,—we have the direct coöperation of moist heat in destroying its vitality, even when the increase in temperature is hardly more than moderate.

"Practical applications of the results of these investigations readily occur. In the first place, they suggest a grave doubt as to the efficacy of some processes of disinfection and antisepsis as they may be carried out during the cold season. Next they teach the great advantage of using antiseptic and disinfecting solutions warm or even hot.

"When the articles to be disinfected can be subjected to the action of the solution for only a short time, as in washing floors or other woodwork, wiping down walls, or rubbing articles of leather or upholstered furniture which cannot be disinfected otherwise, rapidity and certainty of action should be increased by increasing the temperature of the disinfecting solution."

Planning Heating and Ventilating Installments.

The *Master Steam Fitter* for February has a good article upon this important subject. The writer begins with the proposition that, "when the work is well planned, more than half the difficulties are overcome." We should be inclined to amend this proposition by substituting the word "*all*" for the words "more than half." There are rarely any serious difficulties in the mechanical execution of a well-planned job, and any difficulties that arise owing to obstructions in the way of the proper application of principles and natural laws ought to be overcome in making the plans. The drawing-board is the place to work out ways and means, modifications, and allowable compromises, where principles are concerned; and, where any problems of this character are permitted to remain unconsidered, in the hope that they may be solved in some way during the erection of the installation, the latter cannot be said to have been "well planned."

The time will come when contractors will revolt against bidding for unplanned work. They will also revolt against planning work to be estimated for by themselves in competition with other concerns who also plan their own work. The system of presenting complete heating and ventilating plans for competitive bids is growing in favor with architects, and, when the competition is free, with such plans rigidly adhered to, and where none but reputable contractors are invited to compete under the assurance that the lowest bidder will get the contract, no injustice can result, and a plant as good as plans and specifications call for will be assured.

The article under review describes the system employed by D. K. Burnham and Co., a firm of Chicago architects. In planning the work for a building every detail is said to be carefully figured out in the office of this firm before bids are called for. "For this purpose they have in their employ high-salaried, skilful engineers in each department, who plan the work to the finest detail, so that nothing is left for the contractors but to follow the plans. Contractors appear to appreciate this method, because it leaves less for them to do and enables them to do the work with greater dispatch and in the most satisfactory manner."

The plans of the Ellicott building, designed by this firm, are instanced as models of their kind; portions of these plans are presented in the article, as specimens of thoroughness in indicating even minute details. From such a plan the bidder is able to calculate with great accuracy the cost of material, and to judge the amount of labor required in erection. All details of radiating surface, its location and distribution, are given. It would seem that no room is left for misunderstanding, but, should any arise, it can be settled definitely by reference to the plans and specifications.

Mr. C. N. Wilkes, the engineer in charge of this department of D. K. Burnham & Co.'s office business, asserts that, although this thoroughness in planning heating and ventilation installments costs considerable money, the expense is more than saved in the work of erecting; so that, as a measure of economy, it is advisable to draw the plans as near to perfection as possible. It hardly needs to be said that this accuracy involves nothing more than diagrammatic drawings, but the calculations must be made with nicety in the apportionment of heating surface, and in specifying sizes of pipes and fittings.

Hygienic Conditions of Bakeries.

Before the last meeting of the Public Health Association, Dr Jürgensen said that while in nearly all continental countries the conditions of milk supply and meat supply had been made much more wholesome during recent years, that bakehouses, except in Holland, were still very defective from a hygienic point of view. The public, he states, do not show much interest in this question, but would undoubtedly become alarmed if certain features of this trade became generally known. According to Dr. Jürgensen, the principal grounds of complaint are that in the larger towns the bakeries are underground, sometimes in the neighborhood of places of convenience, and that the bakers take their meals in the workrooms. As overwork is quite common in this trade, the health of a good many of the men is very bad, for the inhalation of dust and particles of flour favors the development of tuberculosis, and the considerable variations of temperature produce rheumatism. Numbers of the men also suffer from deformities of the lower extremities, and from want of necessary cleanliness diseases of the skin are very frequent among them. Dr. Jürgensen said that matters are much better in England, where some progress has been made mainly through the efforts of the medical profession. He suggested that underground bakeries should be abolished, that they should be situated on the ground level, and should not be in close connection with dwelling-houses. The floor should be made of polished material so that it may be easily cleaned, all the corners of the rooms should be rounded, and the bakers should wear a working dress that can be washed. A model bakery should have a room in which articles of clothing may be deposited, and a lavatory with bathing accommodation. There should be separate rooms for shaping the dough, cooling, and fermenting, and all the rooms should be ranged round a central office, from which all that goes on may be viewed. The bakers should be divided into two parties, and four hours a day spent in cleaning.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Domestic Engineering in the American, English and British Colonial Magazines, Reviews and Engineering Journals—See Introductory.

Heating and Ventilation.

4207. Heating, Lighting and Ventilating the Capitol. W. L. Crounse (Illustrated description). Safety V–Feb. 2500 w.

4208. " The Breakers," Newport, R. I. (Heating, lighting and elevator running machinery in the country seat of Cornelius Vanderbilt). Safety V–Feb. 1500 w.

*4297. Heating a Theatre-Plant in the Pabst Theatre, Milwaukee, Wis. (Illustrated detailed description). Dom Engng–Feb. 800 w.

4423. Planning the Work (This article is an able argument, with examples of practice in planning heating and ventilating installments, to sustain the proposition that careful planning brings final success at least cost). Mas St Fit-Feb. 1200 w.

4424. Forced Blast Warming With Furnaces. George W. Kramer (Read at the second annual meeting of the Am. Soc. of Heat. and Vent. Engs. Mr. Kramer is the architect to whom the recent impulse in this system of warming buildings is chiefly due, and his paper is full of valuable practical information upon the subject). Mas St Fit–Feb. 4400 w.

4425. Heating and Ventilating of Large Churches. H. B. Prather (Abstract from paper read at the meeting of the Am. Soc. of Heat. and Vent. Engs. The exact requirements of each particular case carefully ascertained, should be the basis of the whole procedure in the design of the plant, in which co-operation of the architect and engineer are considered as essential to high success). Mas St Fit–Feb. 2600 w.

4441. The Pillet Thermophore for Heating Rooms. Ill. (A method of greatly increasing the effect of an open fire-place in heating apartments, while at the same time retaining the advantage of such fire-places for ventilation, as heretofore). Sci Am Sup–Feb. 29. 450 w.

4444. Heating and Ventilation of the Freehold High School (Illustrated detailed description with plans). Heat & Ven–Feb. 15. 1600 w.

4445. A Combination Heater. " Knight " (A practical dissertation on combination systems of warming). Heat & Ven–Feb. 15. 1900 w.

4523. Steam-Heating in a Country Hotel (Detailed description with plans). Eng Rec–Feb. 29. 600 w.

4650. The Heating and Lighting of the American Surety Building (Illustrated description with plans of one of the most complete heating-plants, comprising the most advanced methods, that has yet been placed in a tall office building; with a description of the electric lighting installment, also comprising the latest improvements in the art). Eng Rec–March 7. 3000 w.

Landscape Gardening.

†4179. Horticulture at Ghent (A review of the development and condition of the industry with reference to it as a source of American supply). Con Rept–Jan. 7000 w.

*4265. The Garden in Relation to the House. F. Inigo Thomas (Extracts from a paper read before the Applied Art Section, Society of Arts). Brit Arch–Feb. 7. 3500 w.

4309. The Surroundings of Statues and Monuments (Editorial on the effect of its environment upon a work of art, and the effect of the work upon its environment. Considered specially in regard to the placing of the Sherman statue in Washington). Gar & For–Feb. 19. 1200 w.

4542. The Garden in Relation to the House. F. Inigo Thomas (Full paper read at the Soc. of Arts, with discussion). Am Arch–Feb. 29. 9000 w.

Plumbing and Gas Fitting.

*4295. Fastening Bowls to Marble Slabs. Edwin S. Marsh (Good practical directions for properly doing the work). Dom Engng–Feb. 450 w.

*4296. An Elaborate Bath Room (Illustrated detailed description of a superfine piece of work). Dom Engng–Feb. 300 w.

Miscellany.

*4359. The Berlin System of House Sanitation. Gerard J. G. Jensen (The remarkable backwardness of this city in systems of house sanitation and drainage is in this article contrasted with its remarkable progress in other branches of engineering). San Rec–Feb. 14. 1700 w.

*4533. The Influence of Subsoil Water on Health. S. Monckton Copeman (Brief running review of the various theories, facts and fancies, which have been advanced by observers, and pointing out things that have not yet received merited attention, or concerning which no satisfactory conclusions have yet been reached). San Rec–Feb. 21. 1500 w.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading, and Domestic Engineering.

Steam Engines for Lighting Plants.

UPON this subject Mr. Francis B. Crocker, in *The Electrical Engineer* (Dec. 25), has shown that something remained to be said, if only to give the results of experience in an industry of so recent date and so phenomenal growth as electric lighting. His article is a plain, unprejudiced, and impartial statement of requirements, which close observation of electric-lighting plants has recognized as essential to best results.

First, the wisdom of the old maxim that it is not wise to "put one's fish all in a single bucket" is recognized in his statement that "the number of units in a large central station should be sufficient" to prevent any material interference with the operation of the plant, if one, or even two, of them should be disabled. This is a principle that needs to be observed not only in those manufacturing establishments whose output is dependent upon power, but in those wherein constant running and uniformity of effect or product are required; and it is valid for a refrigerating plant, or for some water-pumping stations, as well as for an electric-lighting central station. While this is a point upon which there will be general agreement, "the relative size" of the units will be variously judged. Some will advocate uniformity of power; others will desire different engine capacities. The first secures the advantage of interchangeability of parts; the second also has its conveniences, and one of its results may be an increased all-day efficiency of the plant. An example illustrating this point is cited.

"In an isolated plant with which the writer is familiar, there is one engine and dynamo of 750 lights capacity, and one of 250 lights, giving a total capacity of 1,000 lights. During the day and late at night the smaller engine can be run very economically with the load, which varies between 100 and 200 lights. When the load increases at the approach of darkness, the larger engine is substituted for the smaller, and supplies power for the 500 to 700 lights which are used during the evening. In this way each engine is almost perfectly suited to its load for long periods of time, the interval between the light load of the day and the heavy load of the evening being so short that the larger engine has to run for only a few minutes at an uneconomically light load, and for an unusually large load both engines can be run at the same time. In the design of central stations a similar judicious selection of engines may give excellent results. For instance, large compound or triple-expansion engines may be operated almost continually to carry the permanent portion of the load with high economy, but for the maximum load, which usually lasts only an hour or two, simpler and cheaper engines may be used."

The possible selection of engines "so that at no time would any one of them be running below 60 or above 125 per cent. of its normal load" is thus indicated. "Ingenuity and judgment" are required in selecting engines that will secure maximum convenience and efficiency. Small engines are usually simple, while large ones will be compound or triple-expansion.

Direct coupling is the simplest and most desirable arrangement, when circumstances admit of its employment, provided its adoption does not "involve sacrifices which offset its advantages . . . . The engine and dynamos must run at the same speed" in this arrangement; but, whereas it is perfectly practicable to run dynamos at from 500 to 1,000 turns per minute, engines have not as yet been made that can take this speed permanently, safely, and economically. For these reasons the system of direct connection has such limitations that, for the most part, transmission of power from engines running at low speed to the dynamos running at higher speeds is and will continue the ruling method. For this purpose Mr. Crocker prefers belting, upon which he remarks:

"Belt-connection has the following advantages: (1) it enables almost any desired ratio of speed to be obtained in a convenient and simple manner; (2) it is cheap; (3) it is applicable to almost any case, provided the space be sufficient; (4) the machines are almost entirely independent, so that either the engine, or dynamo, or both, can be changed, repaired, or operated without interfering with each other; (5) the dynamo is perfectly insulated so far as the belting is concerned, since the latter is almost always made of non-conducting material.

"The general disadvantages of belting are: (1) it requires considerable space, since the machines must be placed a certain distance apart in order to make the belt work properly; (2) the action is not positive, there being a certain slip even in normal working, and, in case of an overload or other trouble, the belt may run off the pulleys, or break; (3) belting sometimes causes unsteadiness in speed, owing to its slipping or flapping on the pulleys, which may produce flickering of the lights; (4) for the same reasons, it may give out noise; (5) belts exert a side pull on the bearings which causes friction and wear.

"The last difficulty can be largely overcome by proper design and attention. Dynamos have been run for years with very little wear in the bearings. The loss of power is also smaller than is often supposed. In fact, belt-connected dynamos have a higher efficiency at light loads, because there is less material than in direct-coupled machines to cause frictional and magnetic losses."

Individual Electric Motors.

In an article by Mr. Oberlin Smith in *Electric Power* (Feb.) the above title is defined as referring to a motor "driving some particular machine (usually in a machine shop or factory) . . . . to which it is especially adapted . . . . in contradistinction to the employment of a motor for driving a line of shafting" through which, by any devices, as belts, gears, sprockets, etc., it imparts motion to "separate machines." Mr. Smith is fertile in happy forms of expression for mechanical ideas, and this term seems an excellent one for the class of motors he discusses in his article. We shall endeavor to give as complete a summary of this article as space will permit in the following abstract.

Although the use of electro-motors for street cars, boats, ventilating fans, and some other individual devices dates back five or six years, it was for some reason considered too radical a departure from old methods to attach such a motor to a lathe or a planer or a driller.

"One reason for this was doubtless the comparatively greater efficiency of the large motors, the manufacturers then having not learned how to make the small ones as efficient as they now do. Another reason probably was the big cost of all motors, and the frequent repairs. The latter difficulty has already nearly vanished, owing to better general design, the use of mica as an insulator, and of carbon rather than metallic brushes upon the commutator. Still greater relief has come, and is yet to come in increasing degree, from the use of induction motors, especially of the polyphase type. Than such a machine as one of these last-mentioned motors it is impossible to imagine anything simpler, unless we compare it with the well-worn analogues of a coffee-mill or a grindstone. When such a machine is properly built, it has but one moving member, and that a symmetrical one, of cylindrical form, attached to an ordinary shaft, revolving in self-oiling journals. Such a mechanism is the *non plus ultra* of absolute simplicity, and practically requires neither attendance or repairs."

The entire practicability of individual motors can no longer be questioned. How about their economy? Mr. Smith has much to say upon this point. As a measure of economy, he evidently favors the substitution of "group-driving motors" (another happy and useful expression) for very small units, when this plan can be conveniently carried out.

"This part-way of compromise methods is in many cases a good one, especially during the transition period, as oftentimes shafting already in use can be separated into shorter lines; and groups of tools can be segregated so as to be run independently in regard to times and seasons, as well as to speed, from the general mass of machinery in the shop. Oftentimes two such short pieces of shafting can be placed lower down than usual, perhaps against a wall or a set of posts, thus allowing more head room for the introduction of cranes, etc. Such grouping of tools, to be actuated by a group-driving motor, is sometimes especially desirable where the room required is very small, as baby motors of a mere fraction of a horse-power capacity have not as yet been made as efficient nor as cheap, in proportion to their power, as have the larger ones, say of one horse-power and upward. This discrepancy, however, time will doubtless remedy to a considerable extent. In the present state of the art, a decision between this group-driving and a strictly individual system must be arrived at in each particular case, according to the special conditions present."

The final question of economy must, however, be decided upon the conditions of working. But the conditions of to-day will be improved. There cannot remain any doubt that the electro-motor of the future will be cheapened. Not perhaps by any marked change in its form, but by new methods of manufacture, so that the element of first cost will be less.

The cost of power, for many purposes, is so small a factor of current expense that it does not, as compared with steam power or gas-motor power, weigh much in the balance of advantages secured by the use of individual electric motors, or group-driving motors, in a shop or factory employing a considerable variety of machines, especially such as must, from the nature of their work, run intermittently.

The advantages set forth by Mr. Smith as gained by individual motors are, in brief, the gain in clear space above machines; increased overhead light available from sky-lights, etc.; additional cleanliness of shops; reduction of noise; increased safety to life and limb; easy and independent control of speed of any particular machine; "adaptability of electric motors to all sorts of machine tools, sometimes as component parts of these tools themselves," which, "when the tools can be of special design," effects in many cases a considerable saving in their cost; independent action of each individual motor, or group of motors; increased facility for locating any machine in any desired place in a shop; and last, an advantage set forth in the following quotation:

"Not least among the advantages of such an open-spaced, well-lighted, clean, quiet shop as has been pictured is its influence in affecting the morale of the workmen. The tendency of such a plant, in comparison with the old-fashioned one, will inevitably be to make men not only cleaner, brighter, and better, but also quicker in their methods of work, on account of the general influence of the electricity genii in the air, so to speak, and the facility with which they can quickly obtain high speeds temporarily for such parts of the work as require them.

"It seems to the writer that the coming of a fashion for the general equipment of new shops with individual motors for many of the machines therein is merely a question of time, and that, it is to be hoped, a comparatively short time. The chief retarding influence will doubtless be the present high cost of small motors. This is to be regretted, but certainly no one can be blamed for it, as electrical companies have all been at an enormous expense in experimentally developing the beautiful and highly-effective motors which they have already produced. They have also been at considerable expense in the way of litigation and competition in selling. Furthermore, they have not, so far, been able to sell these motors in large enough quantity to justify them in going to the expense of making the special tools, and of 'stocking up' with the large batches, which would make possible a really cheap production. It will doubtless be the case, however, that demand and supply will react upon each other, until we shall see some of the methods now used for the production of sewing machines, guns, typewriters, and so on, applied to bringing forth motors in batches of thousands at a time, at a price marvellously less than it was originally supposed they could possibly be produced for. This is obviously possible with sufficient refinement in labor-saving devices, as the raw materials in a motor amount to but a small portion of its total cost."

Electrically-Lighted Life Buoys.

THE far-reaching applications of electricity to all the affairs of life is well illustrated in two articles which have appeared in the interval since our March number went to press. One of these is in *The Electrical Engineer* (London, Jan. 31), and is an attempt to reproduce (feebly, as is confessed) some of the gorgeous effects obtained by ingenious electric lighting in a celebrated pantomime now being presented to crowded houses at a London theater. From this phase of usefulness, wherein the subtle force is made to minister to the public amusement, it is a long step to the situation of a shipwrecked mariner floating by the aid of a life buoy, in the darkness of night, at sea, and in imminent danger of being overwhelmed and lost without being once perceived by any human eye, or receiving the succor that would be generously and joyfully extended could he make known his deadly peril. But even in such a situation can electricity aid the search; and the encouragement which a person in such a peril would feel in knowing that he can be seen, should any friendly eye chance to pass within the limit of vision, would certainly be no insignificant part of the benefit conferred by the simple application of electric lighting to life buoys described in an article in the *Electrical Review* (Feb. 12).

One of these electrically-lighted life buoys has been tested on board the light-house tender *Armeria* with most encouraging results, and has been favorably reported upon to the light-house board in Washington, by Commander West, U. S. N.

The buoy is of large size; its body is a hollow ring of suitable material; a battery suspended by a tubular frame pivoted to the ring depends from the ring, and a tubular metal support for an electric lamp rises to a position above the ring.

The tubular frame for supporting the battery, and the support for the lamp, constitute what, as a whole, may be called a frame, to which the ring buoy is journaled at diametrical points, as described below.

"The ring of the buoy is normally in the plane of the frame; when the buoy is dropped into the water, the ring on which the buoy floats turns so as to rest on its side on the water, and so on turning operates an automatic switch controlling the lights. At the lower end of the frame is the battery box containing the cells. To keep this perfectly dry inside, a moisture absorber is placed there with the cells. The box cover is easily removable, and made water-tight by a packing of rubber with wax or tar. The frame work passes from the ends of the battery box upward, meeting to form an arch over the ring. On top of this arch is the lantern, a glass globe covering one or more pairs of incandescent lamps. Electrical connection between these lamps and the battery cells are through the tubes of the framework on both sides. On each side of the frame is a switch box containing the automatic switch controlling the circuit. The ring is mounted upon trunnions journaled in the switch boxes. Where the trunnion enters the switch box, it is surrounded by a water-tight stuffing box to better protect the switch. The stationary contacts of the switch are secured to the ring trunnions, but, of course, both sets of contacts are insulated from their supports. The contacts are so related to each other that the turning of the ring but a very small angle out of the plane of the frame will close the circuit, and the lamps will remain in circuit and lighted until the ring can be turned around nearly one complete revolution. This precaution is very important, because it will ensure the continuous glow of the lamps in a rough sea.

"Such are the principal features of the machine. There are a few other interesting details added. One is a hand switch concentric with the lantern, added merely by way of precaution; it is so arranged as to be able to switch on one pair of lamps at a time, or turn off all of them. The lamps are in parallel; they are used two at a time, to economize battery power; if one lamp of any given pair of lamps has a filament break, the other can supplement it until another pair of lamps can be switched on. Another addition is a bell below the lantern, automatic or other, which will be of value as a fog signal. The handle of the hand switch is surrounded by a water-tight stuffing box, like that of the automatic switch."

The Present Development and Future Possibilities of Electricity.

In the first of a series of articles with the above title published in *American Machinist* (beginning Feb. 13.) Mr. William Baxter, Jr., takes a very sensible view of the subject, and predicts that in the applications of electricity, or in the conversion of mechanical power into the form of energy which we call electricity, nothing revolutionary is to be expected.

As regards the telegraph and telephone, he takes the position that any improvements that are possible in these lines will be of far more interest and importance to the great corporations which control them than to the general public, and he makes a good argument in support of the proposition that the present methods in use for electric lighting and power are here to stay, and that, although inventors may probably be able to produce electrical appliances which will enable them to go into the general market and compete on a more or less favorable footing with existing machines and appliances, these latter are not in the least likely to be superseded.

Mr. Baxter very justly surmises that investment of capital, though it has been very great, would yet have been much greater, had it not been for a prevalent fear of investors that what is valuable now may at any time deteriorate in value, or even be rendered worthless, by some new, great, and revolutionary invention or discovery. The root of this fear he finds in the current notion that the science of electricity is in its infancy, and that there remains a much larger residuum to be learned than has yet been ascertained about it. There are those who will even assert the admitted fact that we really do not know what electricity is, as though this was true only of electricity, thus making it of special significance as to the strides likely to be made in this field in the future. We do not know what electricity is, or gravity, or matter, or heat, or light. We have theories and useful working hypotheses, but no knowledge. Yet we have been able, through all these agencies, to make remarkable progress. We have learned much of the modes of action of matter under the influence of force; but what is force? The definitions in the text-books are based only upon what force does, not upon what it is. No eye has beheld force, no chemical or physical investigation has been able to isolate it. Some have even denied its existence as an entity, preferring to regard it as the sum of all pre-existences. There has been no end of speculation upon its nature, but it remains insurmountable, and even incomprehensible except in its effects. The knowledge of the nature of electricity is, therefore, no more in its infancy than is our knowledge of the nature of heat, light, and gravity.

"As the layman knows nothing about the conditions required to produce a certain result, he will accept any statement made in relation to the subject as within the limits of possibility. If he is told that the day may come when ten, or even a hundred, times as much power will be obtained from a given amount of electric energy as at the present time, he will likely believe it. Owing to this fact, a great many men hesitate about investing either in electric machinery or electric enterprises, as they fear that at any moment someone is liable to come forward with an invention that will render all present devices practically useless.

"It seems worth while, therefore, to ask and endeavor to answer how much foundation there is for these fears,—in other words, how well grounded is electrical practice, and how clearly can we see what is likely to be the course of future development?

"In the first place, it should be noted to how small a degree new devices have superseded old ones in the past. The first of the modern applications of electricity to be reduced to practice was the arc light. Following this came the incandescent light; but the latter did not supersede the former. On the contrary it occupied a new field of its own. Similarly, the alternating-current system did not supersede the direct-current. Its effect was to render practicable the distribution of electric light over longer distances; but in its own field the direct current is still preferred. In the same way the polyphase system has opened up new possibilities of achievement, but no one expects it to supersede the systems that went before it. So far as electric generators and motors are concerned, revolutionary improvements seem simply impossible. These machines are nothing but converters of energy,—the generator being a converter of mechanical into electrical energy, and the motor a converter of electrical into mechanical energy. These conversions are made at a loss ranging between about seven and twenty per cent. according to the size of the machine; and it will be seen that the margin for improvement in this direction is small. The direction in which improvements in the machines of this class will be made in the future will be in the mechanical details; but even in this direction it will not be possible to make revolutionary advances, as the design of the modern machines has been carried to a high state of perfection. Although improvements in design and construction may be made in the future, they will not be of so much value as to render machinery now in use valueless, any more than the gradual improvement of the steam engine has rendered the older engines valueless. The development that we may expect in electrical machinery will not be so much in the way of improvements on present apparatus as in the adaptation of motors and generators to new uses and devices."

The Coming Electrical Exposition in New York.

NEW YORK city is to have an electrical exposition, commencing on May 4 next and continuing until June 1. The exposition is to be held under the auspices of the National Electric Light Association in connection with its nineteenth convention, and we are assured that it promises to be the largest and most interesting display of electrical apparatus of all kinds ever made in this country, not excepting the displays made at the World's Fair at Chicago, and recently at Atlanta. The exposition will be held in the great Industrial Building, which occupies the entire block on Lexington Avenue between Forty-third and Forty-fourth streets. Many novel and unique features in electrical displays will be introduced in connection with the exposition. There will also be a series of popular and practical lectures on electrical subjects by eminent scientists, and afternoon and evening concerts by famous military bands, with special spectacular effects; all of which will be open to the general public. It is probable that the exposition and convention will, together, constitute the most notable electrical event of the year on this continent.

ABERDEEN, Scotland, possesses the unique position of producing the electric light cheaper than any other city of the United Kingdom. The charge to consumers is only 4d. per unit. *The Electrical Review* (March 6), in making this statement adds that between 1894 and 1895 the amount of load in the generating station was doubled. There are at present 17,000 incandescent and 80 arc lamps connected with the central station, 110-volt incandescent lamps being chiefly used, but 3,000 are of 220 volts. The maximum load averages 2,000 amperes at 110 volts. Seven machines, two of 200 H.P., two of 80 H.P., and three of 40 H.P. are in use. Steam is supplied by two Babcock and Wilcox boilers. The longest circuit worked from the station is about 1½ mile. The plant also supplies 1,000 lamps at the British Railway Station, 200 at the Aberdeen *Gazette* offices, and lights the infirmary.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Applied Electricity in the American, English and British Colonial Electrical and Engineering Journals—See Introductory.

Lighting.

*4081. Lighting Residences by Electricity. Augustus Wall (Showing the variety of conditions to be met in arranging electric lights for the different parts of a costly residence, the methods to be followed, and the precautions to be observed). Eng Mag–March. 3000 w.

4126. Electric-Lighted Life Buoys. James H. Bates (Illustrated description of a device, the invention of C. J. Bates). Elec Rev–Feb. 12. 1100 w.

4131. Dielectric Strength of Oils under Alternating Potentials. Elihu Thomson (Facts sustained by experiments and tests with oil). Elec Eng–Feb. 12. 1300 w.

4137. Economical Results in Modern Isolated Arc Lighting. F. E. Drake (A paper read at the Milwaukee meeting of the Northwestern Elec. Assn. Contains an itemized account and description of the plant owned by J. L. Hudson, Detroit). Elec Wld–Feb. 15. 400 w.

4142. A Commercial Aspect of the Incandescent Lamp. George R. Metcalfe (An examination of the causes that have brought about the unsatisfactory condition of the lamp trade, and considerations that tend to place the competition along the line of quality). Elec–Feb. 12. 2400 w.

*4236. Electric Lighting Acts. 1882 and 1888 (Regulations issued by the Board of Trade for securing the safety of the public, and for ensuring a proper and sufficient supply of electrical energy). Eng, Lond–Feb. 7. 4800 w.

4401. An English Engineer's Views on Arc Lighting Progress. John Hesketh (Also gives a brief summary of the present state of this particular branch of the electrical industry in England). Elec Engng–Feb. 1800 w.

4453. Can the Cost of Isolated Lighting Be Reduced? George R. Metcalfe (The importance of testing lamps, and of determining whether the maximum amount of light is being received for the power generated, etc). Elec–Feb. 26. 2800 w.

4598. Western Electric Iron Clad Arc Dynamos (Illustrated description). Elec Eng–March 4. 2800 w.

4629. A Theatre Electrical Plant (Illustrated description of the installation of the new Olympia theatre, of New York). Elec Wld–March 7. 1400 w.

4670. Electric Light Plant at Chamberlain, S. D., Operated by Artesian Well Power (Illustrated description). W Elec–March 7. 1300 w.

Power.

*4119. Some Characteristics of Synchronous Motors. E. Kolben (From the *Elektrotechnische Zeitschrift*. A contribution to practical knowledge). Elec Eng, Lond–Jan. 31. 1200 w.

4125. Table for Determining Sizes of Commutator Segments (A chart constructed by W. B. Cleveland intended for use in calculating the angular thickness of commutator segments). Elec Ry Gaz–Feb. 8. Table.

4127. Electricity on the Brooklyn Bridge (Illustrated description of a successful test made Feb. 8). Elec Rev–Feb. 12. 1000 w.

4130. Westinghouse Two-Phase Power Plant in the Milwaukee Harvester Co.'s Works (Illustrated description). Elec Eng–Feb. 12. 1200 w.

4167. Electric Driving at the Works of Wm. Wharton, Jr. & Co., Inc., Philadelphia, Pa. (Illustrated description of a machine shop laid out with electric distribution as the key to the arrangement, with reasons which led to the introduction). Am Mach–Feb. 13. 1400 w.

*4199. The Art of Electric Welding (Illustrated account of a visit to the works of the Electric Welding Co. The process due to Prof. Elihu Thomson is explained, and testimony as to its value is given). Elec Rev, Lond–Feb. 7. 2800 w.

*4201. Zerener's Method of Electrical Casting, Welding and Soldering. Ill. From the *Electrotechnische Zeitschrift* (A report on this method and the latest type of apparatus employed). Elec Eng, Lond–Feb. 7. 1100 w.

*4259. Individual Electric Motors. Oberlin Smith (The term defined. The purpose of the article is to take a general glance at the up-to-date development of the electrical system in question. The advantages of individual motor driving are considered). Elec Pow–Feb. 3600 w.

*4260. Note on the Design of Condensers. Harold B. Smith (The practical design and capacity of plate condensers). Elec Pow–Feb. 500 w.

*4261. The Armature. W. H. Freedman (Lecture delivered before the Henry Electrical Club. The various types are classified and illustrated, and an attempt made to present a somewhat logical treatment). Elec Pow–Feb. 1600 w.

*4262. Mechanical Connections between Engines and Dynamos. Francis B. Crocker (Lecture delivered before the Henry Electrica Club. Direct coupling, belting, shafting, rope driving and other apparatus are considered). Elec Pow–Feb. 7000 w.

*4287. Plastic Bond Tests at Buffalo (Some tests on the conductivity of rail joints with plastic bonds. A Weston millivolt meter was used which had just been recalibrated at the factory). St Ry Rev–Feb. 15. 500 w.

4311. A Modern Alternating-Current Station (Illustrated description of the United Electric Light & Power Co. in New York. Station designers desiring to install new plants would do well to carefully study the numerous original methods in this installation). Elec Wld–Feb. 22. 1400 w.

*4408. Theory and Calculations of Asynchronous Alternate Current Motors. A. Heyland (This method of calculation is based upon the practical adaptations of certain peculiar results, at which the author arrived in submitting the phenomena of mutual induction to a graphical treatment. The first part deals with polyphase motors,—deduction of theory and practical applications of the deduction). Elect'n-Feb. 14. Serial. 1st part. 2500 w.

4443.—$1.50. The Twenty-eighth Street Central Station of the United Electric Light and Power Company. H. W. York (Illustrated description, submitted by the author because he believes that in this station are embodied a number of features somewhat unusual in central station design). Trans Am Soc of Civ Engs-Feb. 4400 w.

4451. How to Install an Electric Motor for Blowing Church Organs. S. H. Sharpstein (The problems about such plants are discussed, and explanations of means used to overcome many difficulties). Elec Eng-Feb. 26. 3800 w.

4454. Indicated Evolution in the Storage Battery. Leonard Paget (The writer does not believe the storage battery has been developed to its highest perfection. He considers the subject of its possible evolution by careful study of the constituent elementary parts, viz., the electrolyte, the positive and the negative plates). Elec-Feb. 26. Serial. 1st part. 2000 w.

*4553. The Harrison-Street Electric Supply Station, Chicago (A full description of this latest and best representative of modern American practice, with illustrations). Engng-Feb. 21. 3000 w.

*4583. Present Day Types of Accumulators (A specially contributed article in which the writer proposes to deal with the subject from the standpoint of the owner of a private house lighting installation). Elec, Lond-Feb. 14. Serial. 1st part. 2200 w.

*4586. Electric Elevators. William A. Gibson (General information in regard to the Otis electric elevator). Elec Rev, Lond-Feb. 21. 1600 w.

4619. The Building of a Great Dynamo. H. L. A. (Illustrated description dealing with the machine shop work, and with the winding department operations in natural sequence, as the work is put through the shops). Am Mach-March 5. 1700 w.

4620. Dynamo and Motor Testing. Robert A. Ross (It is the purpose of this article to give a full description of the apparatus and operations involved, so that anyone slightly familiar with electrical terms and appliances may understand and make the tests). Am Mach-March 5. 2200 w.

4628. Water-Power Electric Plants in the United States. Bushrod C. Washington, Jr. (An extensive illustrated article which will be of interest to the general electrical reader as well as to the engineer). Elec Wld-March 7. 3000 w.

4632. Electricity at Niagara Falls. W. E. Tuttle (A description of the plant, in process of construction, of the Niagara Falls Hydraulic Power and Manufacturing Company which it is thought will produce the cheapest power for the money invested of any in this country). Elec Wld-March 7. 1800 w.

*4723. Electrically Controlled Clocks. J. Warren (Some of the ways electricity is utilized in connection with the driving and regulation of clocks. Illustrated by two diagrams). Elec, Lond-Feb. 21. 600 w.

Telephony and Telegraphy.

4138. A New System of Telegraphy (Illustrated description of patents granted Dr. Isidor Kitsee for two systems of signaling, in which high-frequency, but comparatively low-pressure alternating current is used for transmission, and vacuum globes are employed as receivers). Elec Wld-Feb. 15. 500 w.

4143. The Starting of the Telephone Exchange at Chicago. H. H. Eldred (The first of a series of articles on early telephone history. In succeeding articles much unpublished history bearing upon the Berliner patents will be given). Elec-Feb. 12. 1800 w.

4314. How the Bell Telephone Patent was Saved in England (Personal reminiscences of H. H. Eldred). Elec-Feb. 19. 2000 w.

*4387. The Telephone Question. Alfred R. Bennett (Paper read before the East of Scotland Engng. Assn. A consideration of the telephone interests in England, as compared with other countries, with an effort to answer the question why the good results abroad may not be repeated in England). Ind & Ir-Feb. 14. Serial. 1st part. 2800 w.

4402. A Practical Automatic Telephone Exchange System. Charles K. Munns and Fred DeLand (Description, well illustrated). Elec Engng-Feb. 3300 w.

*4411. The Telephoning of Railways. Ill. J. Pigg (Suggestions for the most efficient arrangement of telephone circuits in their adaptation to the special requirements of the railway service). Elec Eng, London-Feb. 14. 2400 w.

*4434. Military Telephony (Illustrated description of the P. Charollois system). Elec Rev, Lond-Feb. 14. 2000 w.

4455. Building a Telephone Exchange in London. H. H Eldred (An account of the difficulties in securing rights from property owners for the running of telephone exchange lines). Elec-Feb. 26. 700 w.

4633. Telephony at Cripple Creek. J. W. Dickerson (A brief historical account). Elec Wld-March 7. 2700 w.

Miscellany.

4111. Electricity Simplified. Nelson W. Perry (The first of a series of papers, written in popular style, aiming to give a clear understanding of this subject). Sci Mach-Jan. 15. Serial. 1st part. 1200 w.

4168. The Present Development and Future Possibilities of Electricity. William Baxter, Jr. (An article in two parts. The first number deals largely with the present and the causes that have retarded progress, but begins to examine the future prospects). Am Mach-Feb. 13. 2000 w.

4174. Magnetic Tester for Sheet Iron (An apparatus devised by Prof. Ewing is described, also the operation of testing). Sci Am Sup-Feb. 15. 1000 w.

*4267. The Effect of Temperature on the Resistance of Paraffin and Resin Oil. H. P. Gaze (Investigations confined to the behavior of paraffin and resin oil, at various temperatures within the range met with in commercial apparatus). Elect'n-Feb. 7. 1400 w.

†4277. Magnetic Permeability of Iron and Steel. Max Osterberg (The principal object of the article is to call attention to the great value of thorough chemical analysis, of a perfect knowledge of the amount of temper a particular piece of iron or steel has undergone). Sch of Mines Quar-Jan. 1700 w.

*4286. Lightning Arresters. W. R. Garton Abstracts from a paper read before the Chicago Elec. Assn. The essentials of a good arrester and things to be considered in placing, etc). St Ry Rev-Feb. 15. 1400 w.

*4293. Alternate Current Transformers (Abstract of Dr. Fleming's third Cantor lecture). Engng-Feb. 7. 1200 w.

4317. Electric Heat in Dental Practice. Dr. Levitt E. Custer, in the *Southern Dental Journal* (The value of electric heat in dentistry is shown by explanation of its many applications). Sci Am-Feb. 22. 1000 w.

4318. Chase's Electric Cyclorama (Illustrated description of an invention which may bring panoramas into fashion again). Sci Am-Feb. 22. 700 w.

*4390. Modern Applications of Electricity. S. T. Harrison (The first of a series of articles on electric lighting, dynamo management and construction, etc., especially written for practical engineers. This rumber consists of introductory remarks, and the design, construction and working of continuous current dynamos and motors). Prac Eng-Feb. 14. Serial. 1st part. 4000 w.

4400. The Protection of an Invention. W. Clyde Jones (The object of the paper is to present some of the facts relating to our patent system, in a manner to be of service as working knowledge to electrical engineers and others engaged in inventive pursuits). Elec Engng-Feb. 4500 w.

4405. Study of the Fuse Problem and Solution. William McDevitt (Tests, lessons and remedy). W Elec-Feb. 22. 3200 w.

*4406. Industrial Electrolysis in 1895. Bertram Blount (A survey of this industry aiming to indicate the direction in which progress is being made and those in which further progress is possible). Elec Plant-Feb. 2300 w.

*4409. The Reichsanstalt Standard Wire Resistances. K. Feussner and St. Lindeck (Abstract from the *Wissenschaftl Abhandl der Reichsenstalt*). Elect'n-Feb. 14. 4500 w.

*4415. Alternate Current Transformers (Abstract of the last of Dr. J. A. Fleming's Cantor lectures on the above subject). Engng-Feb. 14. 1200 w.

4432. Heat from Electricity. J. E. Talbot (Electric heating is considered in this number largely in its application to cooking). Elec Rev-Feb. 26. Serial. 1st part. 1500 w.

*4435. The Blot Accumulator (This invention by G. R. Blot is said to merit careful consideration). Elec Rev, Lond-Feb. 14. 1500 w.

4438. Vacuum Tube Illumination by the D. McFarlan Moore System (Illustrated description). Sci Am-Feb. 29. 1300 w.

†4512. The Velocity of Electricity. Ill. Gifford Le Clear (Investigations tending to show the relation between electricity and light). Pop Sci M-March. 1100 w.

*4558. Magnetization of Iron. Ernest Wilson (A lecture delivered before the Engng. Soc., King's College, London. The time rate of growth of magnetization of iron, and its importance to the electrical engineer). Engng-Feb. 21. 2000 w.

†4578. Modern Theories of Electrolysis. Dr. Joseph W. Richards (Reviews concisely the facts and laws of electrolysis and the attempts to explain observed facts and proven laws by postulating relations which have not yet been fully proven). Jour Fr Inst-March. 8000 w.

4600. Computations for Coil Windings. J. B. Baker (A discussion, giving formula for predetermining the proper dimension and size of wire in winding a coil). Elec Rev-March 4. 700 w.

†4623. Notes on the Theory of Oscillating Currents. Charles Proteus Steinmetz (The object of the article is to present a short outline sketch of a modification of the method of complex imaginary quantities, applied to oscillating currents). Phys Rev-March-April. 3000 w.

†4624. An Experimental Study of Induction Phenomena in Alternating Current Circuits. F. E. Millis (Circuits containing resistance and self induction are discussed in this number. In a further communication the writer expects to consider experiments made upon circuits containing capacity). Phys Rev-March-April. 2000 w.

†4625. Demagnetization Factors for Cylindrical Rods. C. Riborg Mann (Investigations carried on in the physical laboratory of the Berlin University, under the direction of the late Prof. Kundt and Prof. Warburg). Phys Rev-March-April. 2500 w.

†4626. A Photographic Study of Arc Spectra. Caroline Willard Baldwin (Illustrated description of apparatus and outline of the work, with results). Phys Rev-March-April. Serial. 1st part. 3500 w.

4630. Electrical Discharge in the Atmosphere and in Vacuum Tubes. John Waddell (The object of this article is to give a short synopsis of the main facts already known concerning electrical discharge, both in the air at atmospheric pressure and in gases in a rarefied condition, before Röntgen's discovery brought the phrase "cathode rays" into current newspaper literature). Elec Wld-March 7. 2000 w.

*4707. The Lessing Dry Cell. R. Mullineux Walmsley (Report on tests made). Elect'n-Feb. 28. 3500 w.

INDUSTRIAL SOCIOLOGY

Condition of Labor in England Compared With Its Condition in Other Lands.

UNDER the title "Reasonable Patriotism," the Earl of Meath has contributed to the *Nineteenth Century* an interesting paper, in which he contrasts the condition of labor in England with its condition in other lands. In this connection he has much to say concerning labor troubles in the United States. He asks and answers the question whether the introduction of reforms during the last thirty or forty years "has increased, as much as might be reasonably expected, the sum total of the contentment or happiness of the nation," answering it rather hesitatingly and dubiously, as in the following quotation:

"I am far from saying that rich men and women in England devote enough time and money, or attention, to the wants of the poor, the sick, and the suffering. Far from it. I believe the reverse to be the case. All I assert is that, whatever may be our own shortcomings, no other country can show as good a record.

"Our rich men are paupers compared with those of America. The incomes of our landed classes, owing to agricultural depression, have been cut down twenty-five, fifty, and even seventy-five per cent. Their responsibilities remain the same. A county magnate, as well as the humblest squire, has to build and repair farmhouses, cottages, fences, and roads. He is expected to head every subscription list, to take the lead in every philanthropic movement within the district, to assist his church, and to be the general almoner of the distressed of the neighborhood.

"The American millionaire is the absolutely irresponsible master of his own wealth. He possesses no great country mansion or estate, nor has he any hereditary position to support. The public opinion of his neighbors often demands of the English nobleman that he shall maintain the great house in proper condition, and keep up a state commensurate with his social position. The palace, castle, or manor house, with its park and gardens, often bears an historical interest, and is not unfrequently more enjoyed by the public than by himself. If he were seriously to curtail his expenditure, he would be accused of penuriousness, of selfishness, of want of consideration for his poorer neighbors, and the loudest in denunciation would probably be the tradesman who, having for years declaimed in the local radical club against the extravagances of the rich, had suddenly felt, through his pocket, inconveniences arising from the shrinkage in the length of the account annually placed by him for payment in the hands of the great man's agent.

"Every man, woman, and child born on the English magnate's or country gentleman's property considers that he has a certain right to look to him for assistance in the days of distress. No such obligation rests upon the American Dives. The result is that we hear of men who have died in the United States worth as much as £2,000,000 a year. They are able to accumulate. The English land owner is not permitted to do so, even if he should have the wish. In contrast to such enormous incomes, I doubt very much whether any resident native of Great Britain can show a clear income of £500,000 a year. I know, however, of one nobleman in England (and probably there are others) who spends about £60,000 a year in charities alone, quite irrespective of all the good he does for the poor on his own property."

Speaking of the vague feeling among the poorer classes "that the laws and institutions of the country are somehow or other responsible for much of their sufferings," and of the belief entertained by many "that in other countries, particularly in republics, greater freedom is to be found than under a constitutional monarchy, and that the interests of the poor are not as much considered in Great Britain as in some foreign lands," particularly in the United States, he says that this feeling and this belief are not justified by facts. To sustain this position the labor difficulties in the United States, and conclusions derived from them, are dwelt upon in the paper. He quotes John Burns as saying that, during his recent visit to America, he saw slums that would make a Whitechapel slummer blush, and evidence of degradation the like of which he had never seen in London.

In the matter of taxation he thinks the English workman's condition superior to that of American workingmen. He quotes approvingly the *Chicago Times* as saying that "the Chicago system of taxation is systematized crime against the poor," and that this burden has rested upon them for twenty years, and he evidently regards that system of taxation as typical of the burdens imposed upon the poor throughout the land. On the other hand, he alleges that "in Great Britain the workingman, if a teetotaler, may live in comparative comfort without contributing to the revenue of the country."

In short, the purpose of the article is to urge the growth of a "reasonable patriotism" in the rising generation of Britons, by teaching them that, while there are many things in the English social structure to be lamented and even deprecated, it is, on the whole, a better country to live in than any other on the globe, not even excepting the United States. Probably there are some of American birth and education who would accord with this view.

We cannot go into all the details of the comparison made between England and other lands, but it must be confessed that a very strong argument is made in support of the main contention that "the Old Country is, after all, not a bad place to live in," and that the rising generation ought to have the fact impressed upon their minds as a part of their education. As a whole, this is one of the most interesting and instructive of the contributions to the sociological literature of the month. The optimistic tone of the paper contrasts strongly with most current sociological literature.

The Industrial Revolution in Japan.

THE marvellous progress in all the arts of civilization made by the Japanese within the last three decades has no precedent in the history of nations. In another department their creation of a mercantile marine of no mean proportions in the short space of twenty-five years is noted. Mr. William Eleroy Curtis, in an article of twenty pages in the *Bulletin of the Department of Labor* for January, tells the wonderful and interesting story of Japanese progress in the manufacturing industries. Of this article we make the following abstract, presenting some of the more interesting features of a great social and industrial transformation.

We are told by Mr. Curtis, who writes from personal observation in Japan, that that country is becoming less and less dependent upon foreign nations for the necessities and comforts of life, and that she is making her own goods with the greatest skill and ingenuity. Studying the methods of all civilized nations, the Japanese have adopted those of each which seem to them most suitable, and have rejected what is of no value to them as often as they have adopted those things which are to their advantage.

It is only forty years since the ports of Japan were forcibly opened to foreign commerce. It is only twenty-eight years since the first labor-saving machine was set up within the limits of the empire. The exports and imports now exceed $115,000,000. A table of the kinds and values of imports shows that their general character corresponds very favorably with those of the older civilized countries.

In 1894 Japan exported goods to the United States amounting to $21,661,779; to France, $9,749,388; to Hong-Kong, $8,099,740; to China, $4,406,994; to Great Britain, $2,975,099; to British India, $1,844,079; and to Germany, $758,774,—a total of $49,495,853. Japan also exports goods in small amounts to nearly every nation in the world.

In the same year she imported goods from Great Britain of the value of $21,094,937; from China, $8,755,753; from the United States, $5,491,279; from British

India, $5,280,224; from Hong-Kong, $4,-499,859; from Germany, $3,954,771; and from France, $2,174,024,—a total of $51,-250,847.

The industrial revolution that is now going on in Japan is quite as remarkable as the political revolution that occurred there thirty years ago, and equally important to the rest of the world. Until recently, all the manufacturing done in Japan has been in the households, and ninety-five per cent. of the skilled labor is still occupied in the homes of the people and in a measure independent of the conditions that govern wage-workers in other lands. The weaver has his loom in his own house, and his wife, sons, and daughters take their turns at it during the day. It has always been the custom for children to follow the trade of their parents. The finest brocades, the choicest silks, the most artistic porcelain, cloisonne, and lacquer work, are done under the roofs of humble cottages, and the compensation has heretofore been governed usually by the quality of the piece produced.

"The ancient system of household labor is being rapidly overturned by the introduction of modern methods and machinery. The older artisans are offering a vain resistance, and can not be drawn from their antique looms and forges by any inducement that has yet been offered; but the younger generations are rapidly acquiring a knowledge of the use and value of labor-saving machinery, and factories are being built in all parts of the empire. The greatest progress thus far has been made in cotton spinning and weaving, but several iron mills have been established, and machine shops are springing up all over the empire. In four years the new treaties go into effect, when foreigners will be allowed to engage openly in manufacturing enterprises. Then their capital and experience will give a decided stimulus to mechanical industry, and the increase in the productive power of Japan will be even more rapid than now.

"The first manufactory established in Japan was a cotton mill down in the southwestern corner of the empire, in the province of Satsuma, which has produced the best pottery and some of the greatest men. Prince Shimazu was its patron. Having learned something of modern arts and sciences from the Dutchmen who were allowed to remain on the island of Deshima, he started a laboratory on his estates in which he learned telegraphy, photography, and how to make glass, coke, and gas for illuminating purposes. A few years later he built a factory near his summer villa, which was half arsenal and half iron foundry. He made guns there and other articles of iron, and experimented with explosives.

"All the work in both institutions was conducted under his personal supervision, with the assistance of Dutch chemists, from whom he heard that much could be learned about such matters from books. So he started a retainer to Nagasaki, charged with the duty of securing whatever books on chemistry, natural philosophy, and other scientific subjects could be bought or borrowed. And an order was left with a merchant at Deshima to procure for him a copy of every scientific publication that was issued. In this way a considerable library accumulated, and the books were translated to the prince, as fast as they came, by a schoolmaster who had learned English at Deshima and whose services were secured."

The next factory was erected in Tokyo in 1867 Starting with 720 spindles, it now operates 82,000, and is the largest in the empire. In 1879 two more were started, four more in 1880, four more in 1881, one in 1882, another in 1883, and another in 1884. Started by the government, these have all passed into the hands of private owners. Their number has increased to 61, operating 580.564 spindles, and employing 8,889 male and female operatives,

The first genuine foreign factory to be established in Japan is the Osaka Tokei Seizo Kubushiki Kwaish̃r, familiarly known as the American Watch Company. It was started on January 1, 1895, and turned out its first finished watch on April 10. The organizer and promoter of this company was Mr. A. H. Butler, of San Diego, Cal., who took an outfit of watch-making machinery to Japan, and induced a number of jewelers and watch-dealers in Osaka to furnish $160,000 capital to pay the cost of a building and the running expenses of the business. The company is incorporated under Japanese law, and the stock is all in the name of Japanese citizens, although one hundred and forty of the three hundred shares actually belong to Mr. Butler and his associates.

As no foreigner is allowed to engage in manufacturing outside of certain limited districts in the treaty ports of Japan, pending the enforcement of the new treaties in 1899, it was necessary for Mr. Butler to evade the law, which he did, with the knowledge and consent of the authorities, by having his stock issued in the name of Japanese trustees, who assigned to him the certificates in blank and gave him a written agreement to protect his interests. At the end of four years Mr. Butler will have the stock registered in his own name, and become an officer of the company. An American superintendent and nine assistants were employed to instruct native workmen. These gentlemen say that their Japanese students show very great aptitude and skill, and that they learn much more rapidly and have a much more delicate touch than persons of similar intelligence and condition in the United States. Nearly all of them had had some experience in making or repairing watches and clocks before they came into the factory, and a few had used hand-machines for drilling, polishing, and that sort of work; but the modern machinery at which they were placed was entirely new to them. They are mostly young men, aged from eighteen to thirty. As none of them can understand a word of English, and none of the American experts could speak Japanese when they arrived, the work of instruction might have been very slow but for the keen perception of the pupils.

It is said that the quickest way to instruct the Japanese in any handicraft is to go through the process and let them look on. Almost instantly they are able to repeat, and to continue repeating it, perfectly. Labor is attainable at very low prices. The native watchmakers get about twenty cents a day as the highest wages, the lowest being five cents a day. A tabulated statement of wages for all occupations is given, the average for each being very low. Many further particulars of great interest are given in this paper, which will well repay the reading.

Socialism for the Millionaire.

A PAPER under the above title by Mr. George Bernard Shaw, in the *Contemporary Review* for February, is one of the most interesting contributions to the sociological discussions of the month. It is not the less to be styled thoughtful, because parts of the paper are enlivened by a fine vein of humor. All sparkling wines are not good wines because they sparkle. But Mr. Shaw's paper may be compared to a rare quality of champagne, which, even if it were a still wine, would yet be good and valuable. Samples of this humor are found in the following quotations:

"The millionaire class, a small but highly interesting one, into which any one of us may be flung to-morrow by the accidents of commerce, is perhaps the most pitiably neglected in the community. . . . In reviewing the advertisements of the manufactures of the country, I find that everything is produced for the million and nothing for the millionaire. . . . . Whilst the poorest have their Rag Fair . . . . where you can buy a book for a penny, you may search the world in vain for the market where the £50 boot, the special cheap line of hats at forty guineas, the cloth-of-gold bicycling suit, and the Cleopatra claret, four pearls to the bottle, can be purchased wholesale. Thus the unfortunate millionaire has the responsibility of prodigious wealth without the possibility of enjoying himself any more than any ordinary rich man."

A single exception to the millionaire's limitations is named in the quotations below; but this is of a nature which can hardly contribute much to his comfort in life.

"The millionaire can have the best of everything in market, but this leaves him no better off than the modest possessor of £5,000 a year; there is only one thing that he can order on a scale of special and recklessly expensive pomp, and that is his funeral. Even this melancholy outlet will probably soon be closed. Huge joint-stock interment and cremation companies will refuse to depart to any great extent from their routine of Class I, Class II, and so on, just as a tramway would refuse to undertake a Lord Mayor's Show. The custom of the great masses will rule the market so completely that the millionaire, already forced to lead nine-tenths of his life as other men do, will be forced into line as to the other tenth also."

Let it not, however, be supposed that the millionaire fills no important *rôle* in the economy of the universe. He has a use, which like the X-rays and argon, has only recently been suspected and traced to definite discovery. We are not sure that Mr. Shaw himself ought not to be credited with the honor of this discovery; at any rate, he has formulated the true function of the millionaire as a factor in human existence. The millionaire creates needs, and converts luxuries into necessities. Thus it may be some recompense to him to feel that his life has even this much influence upon his environment; but his disappointments and sufferings are numerous and peculiar to his class. "Indeed, in many things he cannot enjoy himself more than many poor men do, nor even so much; for a drum-major is better dressed; a trainer's stable-lad often rides a better horse; the first-class carriage is shared by office-boys taking their young ladies out for the evening; everybody who goes down to Brighton for Sunday rides in the Pullman car; and of what use is it to be able to pay for a peacock's-brain sandwich when there is nothing to be had but ham or beef? The injustice of this state of things has not been sufficiently considered. A man with an income of £25 a year can multiply his comfort beyond all calculation by doubling his income. A man with £50 a year can at least quadruple his comfort by doubling his income. Probably up to even £250 a year doubled incomes mean doubled comforts. After that the increment of comfort grows less in proportion to the increment of income, until a point is reached at which the victim is satiated and even surfeited with everything that money can procure. To give him another hundred thousand pounds, under the impression that you are benefiting him, and on the general ground that men like money, is exactly as if you were to add two hours to the working-day of a confectioner's employee on the general ground that boys are fond of sweets. What can the wretched millionaire do that needs a million? Does he want a fleet of yachts, a Rotten Row full of carriages, an army of servants, a whole city of town houses, or a continent for a game preserve? Can he attend more than one theatre in one evening, or wear more than one suit at a time, or digest more meals than his butler? Is it a luxury to have more money to take care of, more begging letters to read, and to be cut off from those Alnaschar dreams in which the poor man, sitting down to consider what he will do in the always possible event of some unknown relative leaving him a fortune, forgets his privation? And yet there is no sympathy for this hidden sorrow of plutocracy. The poor alone are pitied. Societies spring up in all directions to relieve all sorts of comparatively happy people, from discharged prisoners in the first rapture of their regained liberty to children revelling in the luxury of an unlimited appetite; but no hand is stretched out to the millionaire, except to beg. In all our dealings with him lies implicit the delusion that *he* has nothing to complain of, and that he ought to be ashamed of rolling in wealth whilst others are starving."

And, as civilization advances, his plight gets worse instead of better.

"The old-fashioned tradesman, servile to the great man and insolent to the earner of weekly wages, is now beaten in the race by the universal provider, who attends more carefully to the fourpenny and tenpenny customers than to the mammoth shipbuilder's wife sailing in to order three grand pianos and four French governesses. In short, the shops where Dives is expected and counted on are only to be found now in a few special trades, which touch a man's life but seldom. For every-day purposes the customer who wants more than other people is as unwelcome and as little worth attending to as the customer who wants less than other people."

What is the millionaire to do with his surplus funds? "The usual reply is, provide for his children and give alms. Now, these two resources, as usually understood, are exactly the same thing, and a very mischievous thing too. From the point of view of society, it does not matter a straw whether the person relieved of the necessity of working for his living by a millionaire's bounty is his own son, or merely a casual beggar of no kin to him. The millionaire's feelings may be more highly gratified in the former case; but the mischief to society and to the recipient is the same. Even the private feeling in this matter is changing, and changing rapidly. If you want to spoil a young man's career, to annihilate his efficiency and enfeeble his character, clearly there is no method surer than that of presenting him with what is called 'an independence,' meaning an abject and total dependence on the labor of others."

The paper regards the alternative of giving huge sums to trustees "to do good with" as mischievous. "There is no getting over the fact that, the moment the attempt is made to organize almsgiving by entrusting funds to a permanent body of experts, it is invariably discovered that beggars are perfectly genuine persons: that is to say, not 'deserving poor,' but people who have discovered that it is possible to live by simply and impudently asking for what they want until they get it, which is the essence of beggary. The permanent body of experts, illogically instructed to apply their funds to the cases of the deserving poor only, soon become a mere police body for the frustration of true begging; and consequently of true almsgiving. Finally, their experience in a pursuit to which they were originally led by natural benevolence turns them to an almost maniacal individualism and an abhorrence of ordinary charity as one of the worst of social crimes. This may not be an amiable attitude; but no reasonable person can fail to be impressed by the certainty with which it seems to be produced by a practical acquaintance with the social reactions of mendicity and benevolence."

The remainder of this excellent paper is an arraignment and criticism of the prevailing system of public charities, which is regarded as actually fostering the growth of the classes for whose relief it is intended to provide.

THE revenue of Western Australia continues to expand. In January the colony's income was £130,729, an increase of £30,414, or roughly, 30 per cent. The main item of increase came from customs duties, which rose £20,984, or over 50 per cent. The primary cause of the all round increase is due to the development of the goldfields.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Industrial Sociology in the American, English, and British Colonial Magazines, Reviews and Engineering Journals—See Introductory.

*4082. The Scotch System of Branch Banks. J. Selwyn Tait (Showing that the National and State banks lock up $750,000,000 of capital, which the adoption of the Scotch branch bank system would release for purposes of enterprise). Eng Mag-March. 3500 w.

*4083. The Money Question and Constructive Enterprise. John R. Dunlap (Designed to present the subject from the standpoint of the engineer, architect, and practical men generally, and showing the essential importance of sound finance to progressive industrial development.) Eng Mag-March. 4200 w.

†4139. Socialism for Millionaires. George Bernard Shaw (The thrusts of this writer are made with a keen and polished blade. The unfortunate millionaire is considered as bearing the responsibility of enormous wealth without the possibility of enjoying himself any more than an ordinary rich man, and sympathy is extended to him for being in this pitiable plight. It is on the whole concluded that the function of the millionaire in the economy of the universe is to create needs and to raise mere luxuries to the, so to speak, higher power of necessities. Thus he becomes a benefactor to the human race). Contemporary Rev-Feb. 6800 w.

4151. Municipal Control of Street Car, Water and Gas Plant (Considers the control as the natural and rightful tendency of progress). Can Eng-Feb. 1400 w.

†4154. The Poor Colonies of Holland. J. Howard Gore (Dr. Gore was the U. S. Com. Gen. to the International Exposition at Amsterdam in 1895. The information embodied in this article was collected by him during a visit to the

poor colonies in July of that year. This interesting account shows that as compared with impoverished people of other lands, the poor colonies of Holland are in a much better condition. They are not abased by their benefits, nor caused to feel that they are paupers by acceptance of gratuities. The system is a good sociological study). Bul Dept of Labor–Jan. 6500 w.

†4155. The Industrial Revolution in Japan. William Eleroy Curtis (The facts on which this article is based were collected by Mr. Curtis, personally, while in Japan during the past year. Values stated in American gold on the basis of 2 silver yen to the dollar. It was only forty years ago that the ports of Japan were forcibly opened to foreign commerce. It was only twenty-eight years ago that the first labor saving machine was set up in that country. The exports and imports now exceed $115,000,000. The article gives an account of this wonderful progress, and a forecast of the industrial future of the Japanese). Bul Dept of Labor–Jan. 7700 w.

†4156. Recent Reports of State Bureaus of Labor Statistics (Colorado, Illinois, Maine, Maryland, New Hampshire, Ohio). Bul Dept of Labor–Jan. 8000 w.

†4157. Trade Unions in Great Britain and Ireland (General digest of the Seventh Annual Report of the Labor Dept. of the British Board of Trade, so far as it deals with trade unions. Contains an array of reliable statistics). Bul Dept of Labor–Jan. 1700 w.

†4158. Wages and Hours of Labor in Great Britain and Ireland (Synopsis of a report on this subject, published by the Labor Dept. of the British Bd. of Trade. Tabulated statistics, etc). Bul Dept of Labor–Jan. 2700 w.

†4159. Strikes in Switzerland in Recent Years (Statistics compiled from the eighth annual report of the Comite Directeur de la Fédération Ouvrière Suisse, 1894. A historical review). Bul Dept of Labor–Jan. 700 w.

†4160. Notes Concerning the Money of the United States and Other Countries. William C. Hunt (These notes contain tabulated statements of value for ready reference). Bul Dept of Labor–Jan. 2000 w.

†4161. The Wealth and Receipts and Expenses of the United States. William M. Steuart (The true value is what would be deemed a fair selling price for the property, and is thus termed in distinction from the assessed valuation. The presentation of these subjects is not designed to develop details but to show in a form for easy reference, increase and decrease in wealth, receipts and expenses). Bul Dept of Labor–Jan. 1200 w.

†4162. Decisions of Courts Affecting Labor (Review of recent decisions rendered by the supreme courts of different states, and of the United States, affecting the legal status of employers and employed). Bul Dept of Labor–Jan. 13000 w.

†4163. Extract Relating to Labor from the New Constitution of Utah (Sections 1 to 7 inclusive). Bul Dept of Labor–Jan. 400 w.

†4164. Exports Declared for the United States (Quarter ending Sept. 30, 1895. The usual complete list). Con Repts–Jan. 19500 w.

*4232. Continental and English Wages (A comparison of wages in steel works). Ir & Coal Trs Rev–Feb. 7. 700 w.

†4280. The Diversity of Banking Systems (Review of reports on this subject collated by the Comptroller of the Currency). Banker's Mag–Feb. 600 w.

†4281. Edward Atkinson's Elastic Currency Scheme (Criticism of this scheme. The ground is taken that the issuance of the certificates of deposit proposed by Mr. Atkinson, and which he thinks might take the place of bank notes and legal tender notes, at least to some extent, would be an evasion of the law and therefore an impracticable scheme). Banker's Mag–Feb. 1000 w.

†4282. A Study of National Finances (Editorial review of a scheme proposed by M. D. Kenyon, Supt. of the Banks of the State of Minnesota, which is novel and which it is thought will command attention. The proposition is that Congress should enact a law constituting the greenbacks an interest-bearing debt, which, he believes, would result in locking them up as bank reserves, even if the interest should be no higher than one per cent.). Banker's Mag –Feb. 600 w.

†4283. Description of State Banking Systems (Compiled from the Annual Report of the Comptroller of the Currency, and including the systems of Nebraska, New Hampshire, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, and Oregon). Banker's Mag–Feb. 2500 w.

†4284 Reasonable Patriotism. Earl of Meath (An inquiry whether the efforts made by the British State and nation to improve the lot of the toiling masses has increased the contentment, or elevated the condition of these masses as much as should reasonably have been expected. The answer is that no other country can show so good a record, and that the present status of labor is better in England than in other countries, not excepting the United States). Nineteenth Cent–Feb. 11500 w.

*4292. Naval Contracts for the Thames (An able editorial. An endeavor by means of public agitation to get the British government to give more contracts to the Thames ship-yards has given rise to a debate, herein reviewed, which covers nearly all of the relations of employers and employed, and the question of government control of the economics of labor. The situation as herein portrayed is very interesting as a sociological study). Engng–Feb. 7. 3600 w.

*4373. A Successful Experiment for the Maintenance of Self-Respecting Manhood. B. O. Flower (History and successful results of the plan devised by Mayor H. S. Pingree, of Detroit, Mich., to assist needy but industrious citizens by giving them free use of unimproved and uncultivated lands within the city limits). Arena–March. 2500 w.

*4374. The Human Problem According to Law. Abby Morton Diaz (The cause of our social disorder is found in law-breaking of various kinds, natural, civil and ethical—the penalties of which violation are disorder, oppression, repression, fierce competition, rivalry, dishonor, corruption, injustice and unlimited self-seeking. From this point of view the remedy is obvious—"law keeping"). Arena-March. 2700 w.

*4375. Wealth Production and Consumption by the Nation. George B. Waldron (The purpose of this article is (1) to measure the annual production of the United States; (2) to distribute this production among the families of the nation according to their probable income; (3) to show the final disposition of the total product, and thus to open a way for the measure of the congestion of wealth, which is a social feature of the time). Arena-March. 3000 w.

4376. Increase of Cotton Mills (Editorial. The great increase in the number of spindles in cotton manufacturing during the past year having given rise to a doubt that the business may have been overdone, the article attempts, with some success, to demonstrate that cotton manufacturing has not been overdone, that there is no present danger that it will be, and that it is yet a favorable and inviting field for investment). Bos Jour of Com-Feb 22. 1200 w.

4379 The Foreign View of the Loan (An editorial compilation of views, expressed in the British and European press, relative to the recent bond issue of the United States government). Bradstreet's-Feb. 22. 1100 w.

4380. Excluding Illiterate Immigrants (Editorial advocating restrictions of immigration by educational qualifications for eligibility). Bradstreet's-Feb. 22. 600 w.

4381. British Foreign Trade and Our Share in It (That the United Kingdom has entered upon a period of renewed prosperity, and that the relations of the commerce of the United States to British commerce are such that American commerce must share in this prosperity. appears to be the opinions set forth in this editorial). Bradstreet's-Feb. 22. 900 w.

*4456. The Industrial Condition of the South after 1860. Richard H. Edmonds (Tracing the progress of the South from the Civil War, which left it in poverty and woe, to the present. Its decline, followed by surprising growth since 1880. A brief statement of its natural resources and wealth-creating possibilities). Chau-March. 4500 w.

4467. The Labor Question. R. A. Hadfield (Expresses the belief that piece-work, in many cases, does not possess advantages attributed to the system; and this is followed by an argument for the daily wage system. Incidentally an account of an organization called the Industrial Union is given). Foundry-Feb. 2800 w.

*4468. The Importation of Foreign Prison Made Goods (Report of a departmental committee of the British board of trade. After a thorough investigation of the extent to which goods made in foreign prisons are imported into the British markets, the committee find them so unimportant that no steps toward their restriction are required, and that any action of this kind would produce more harm than good). Bd of Tr Jour-Feb. 1200 w.

*4471. Tariff Changes and Customs Regulations (These changes are noted as nearly to date of publication—Feb., 1896—as practicable). Bd of Tr Jour-Feb. 1600 w.

4492.—$1. The Multiple Money Standard. J. A. Smith (Topics discussed in this paper are (1) the relation of money to industrial society; (2) two conceptions of a standard value; (3) gold as an unstable commodity; (4) a composite gold and silver standard; (5) the tabular standard; (6) the multiple money standard; (7) the circulating medium; (8) a national vs. an international standard of value; (9) the multiple standard and the economic problem of distribution. The socialists are declared to be right in claiming that the crucial test of normal distribution is the maintenance of an efficient demand, but wrong in asserting that the competitive system is essentially vicious). An Am Acad-March. 20000 w.

4493.—$1. Individual Determinism and Social Science. G. Flamingo (This paper refers all social phenomena to an individual basis, and maintains that individual character is a result of the conditions of social and natural environment and hereditary environment; yet, under new conditions it reacts in an entirely mechanical manner. It also states and maintains the principle that it is impossible for a mass of populalation entirely "determined" in its action, to result from many individuals, relatively free, as the theories of individual free will affirm). An Am Acad-March. 4200 w.

*4500. Some Municipal Problems. E. W. Bemis (In addition to the municipal problems that have hitherto absorbed most of the energies of civic federation, this paper relates to the problem of raising and expending municipal revenues, and the attitude of the city toward monopolies of situation, such as light, heat and transportation). Forum-March. 5000 w.

†4501. Our Foreign Trade and Our Consular Service. Charles Dudley Warner (The effect upon the improvement of the consular service of the executive order of Sept. 20, 1895, is considered, and the extension of American trade as dependent upon greater efficiency in the consular service, action of manufacturers, merchants and exporters, and active interest of the government). N Amer Rev-March. 5500 w.

*4503. The Hungarian Millennial Exhibition at Budapest (An outline of what is anticipated will be a very successful exposition, in which the flour-milling industry will be one of the greatest features). Mach, Lond-Feb. 15. 900 w.

4518. Grain Going to Gulf Ports (Reviews the complaint of New York interests that this is due to enforcement of the Joint Traffic Association rates. The opinion is hazarded that some of the changes in currents of traffic are more likely to be permanent than in former years). Bradstreet's-Feb. 29. 900 w.

†4536. Cotton Mills of Japan (Tabulated statistics obtained from the Japanese consulate). Cons Rept-March. 1000 w.

4590. Farming on Vacant City Lots (Editorial discussing a pamphlet published by the New York Association for Improving the Condition of the Poor, and showing the beneficial results from the carrying out of Mayor Pingree's idea). Gar & For–March 4. 1500 w.

4611. Pending Trade Mark Legislation (Editorial. Discusses, with approval, a pending amendment to the present U. S. trademark law, which provides for granting trademarks used in commerce among the states, and not restricting it as heretofore, to goods used in commerce with a foreign nation or some Indian tribe). Sci Am–March 7. 1400 w.

4661. Bank Clearings Increasing (Tabulated presentment of bank clearings at 87 cities for February, at 83 cities for the month and two months this year and last, and at 75 cities for four years. The table indicates an increase of bank clearings). Bradstreet's-March 7. 800 w.

4662. Comptroller Eckels on the Currency (Editorial review of recent address at the banquet of the Massachusetts Reform Club, in which the cause of the weakness of the credit of American currency is traced to the fact that since the issuance of the first treasury note, in 1862, the inflationist has been the controlling force in American monetary legislation). Bradstreet's–March 7. 900 w.

4663. British Investment Funds and Investments (Editorial comments upon the recent rise in the price of British consols, the decrease in the interest paid on these securities and the marked tendency of British investors to take a more active interest in American securities). Bradstreet's-March 7. 900 w.

4664. Present and Future of Africa's Commerce (In this article it is contended that notwithstanding the small amount of commerce in proportion to area at present carried, the turn of Africa has come, and need for her coöperation in the general economy of the world will increase). Bradstreet's–March 7. 1300 w.

†4675. Social Control. Edward Ailsworth Ross (An attempt to concisely express the characteristics of true society as distinguished from all other aggregates and combinations of men. Our first duty, it is asserted, is to search the field of rewards and punishments for the means of social control). Am Jour of Soc–March. 8000 w.

†4676. A Belated Industry. Jane Addams (An attempt is made to present this industry from the point of view of those women who are working in the household for wages. The opinions have been largely gained through experiences in a Woman's Labor Bureau and through conversations held there with women returning from the "situations" which they had voluntarily relinquished in Chicago househo'ds of all grades. These same women seldom gave up a place in a factory, although many of the factory situations involved long hours and hard work). Am Jour of Soc–March. 5800 w.

†4677. A Programme of Municipal Reform. Franklin MacVeagh (Bad city government is regarded as one of the most hopeful of modern problems in reform, from the fact that it has come to be almost fully and generally realized. General lines upon which the solution of the problem should be attempted, are laid down). Am Jour of Soc–March. 4400 w.

†4678. Scholarship and Social Agitation. Albion W. Small (The main purpose of this paper is to challenge the claims of that type of scholarship which assumes superiority because it deals only with facts, and which is regarded as obstructive in proportion to its insistence that nothing belongs in its province except demonstrative evidence. It is the present duty of scholarship to reconsider all that is involved in the existing institution of property). Am Jour of Soc–March. 6500 w.

*4679. Are We a Nation of Rascals? John F. Hume (The thesis is that instability in money always results in injustice. Whichever way it fluctuates someone is defrauded. The substitution of a fifty per cent. silver for one-hundred per cent. gold dollar, as now urged by many, would be the gigantic fraud of the century, and would make us a nation of rascals). Am Mag of Civ–March. 3800 w.

*4680. Canadian Tariff Reform. J. W. Russell (The economic unity of the North American continent is postulated, and freer trade between Canada and the United States is claimed to be the natural corollary. This corollary is held to be implied in the statement of the tariff policy advocated by Canadian liberals. That Canada will follow the United States in the direction of tariff reform is regarded as probable, and reasons for this view are given. The liberals in Canada even now maintain that tariffs should not be based on the protective principle, but upon the requirements of the public service). Am Mag of Civ–March. 3500 w.

*4681. The Iron Law of Wages. Charles Drake (The iron law of wages is viewed as the result of a combination of Malthus's law of population, and Ricardo's theory of rent. Under this logical result, it has come to pass that the earth can barely support the population living upon it. To prove these propositions, theories are compared with facts, and it is concluded that both Malthus and Ricardo are wrong, and that the iron law of wages based upon these doctrines, is as false as the doctrines themselves). Am Mag of Civ–March. 1500 w.

*4682. Banking and the Currency. Lewis R. Harley (A review of the history of the currency and of banking during the nineteenth century). Am Mag of Civ–March. 5000 w.

*4683 The Problems of Charity. Robert Treat Paine (From an address before the National Conference of Charities and Correction. The true principle of business is regarded as lying between avarice on the one hand and charity on the other; and on this plane are found such organizations as working men's loan associations, the beneficent effects of which are urged and dwelt upon). Am Mag of Civ–March. 2500 w.

4705. Statistical Studies Concerning Labor Conditions. Director H. Schneider (Translation from the German, of a paper describing an investigation of the health statistics of working people, employed in gas works for a period of 32 years. The results indicate that this labor is not more unhealthy than the average of other occupations). Am Gas Lgt Jour–March 9. 1200 w.

MARINE ENGINEERING

Development of the Japanese Mercantile Marine.

THE following abstract of correspondence in *Engineering* (London, Jan. 31) indicates the progress of the Japanese in marine construction.

"The Japanese mercantile marine has only been in existence for a little over a quarter of a century. At the end of 1870 the total number of ships of European form, both steam and sailing, was 46, with an aggregate registered tonnage of 17,952 tons."

A table giving the rates of tonnage of Japanese and foreign vessels shows that 18.6 per cent. has been carried in Japanese ships, and another table shows that the freight earnings of Japanese ships have been 1.3 per cent. of the total. This discrepancy between the earnings and the increase in tonnage of the Japanese vessels having attracted the attention of the Tokyo chamber of commerce, a discussion of the subject was followed by a memorial to the ministers of State for finance, agriculture, and commerce. Communications were made, containing some very important proposals, which at least show that the Japanese are ambitious of taking a leading position among the mercantile nations of the world.

In order to indicate the extent of that ambition, we have only to mention that the memorialists dilate on the importance of extending the steam service of Japan to America, Europe, Australia, and other foreign parts. Seven such lines are mentioned. First, the Tientsin line, to connect Japan with the ports of Korea and North China; it is proposed to open this as a mail line, with one vessel every week. Secondly, the Shanghai line, which is also to be a weekly mail service. Thirdly, the Vladivostock line, the vessels of which would touch Korean ports, *en route;* also a mail line with weekly service. Fourthly, the China sea line, touching at ports in South China, and extending as far as Tonkin, Saigon, and Siam. This is to be a mail line with fortnightly services. Fifthly, the European line connecting Japan and London or Liverpool. This it is proposed to open gradually, the first step being to convert the Nippon Yusen Kaisha's present Bombay service into a mail line, and to arrange that the company shall establish a periodical freight service to Europe by way of trial. Sixthly, the American line. This, it is suggested, should be run as a mail service at least once per month, by large steamers capable of being converted into cruisers in time of war. Seventhly, and lastly, the Australian line. This is to have either Melbourne or Adelaide as its objective point, and its immediate opening as a monthly line is recommended. It is proposed that each of these lines should be subsidized; the memorialists do not enter into the details of this part of the subject, but leave the matter to the authorities, merely observing that the allowance must necessarily vary according to the articles of contract.

No doubt this very extensive programme will be received with a smile by those who know the difficulties involved in carrying it out, but the correspondent of *Engineering* says the doubters may rest assured that the Japanese will ultimately succeed. As with all their other projects, they have carefully thought out the details, and, while developing the practical part of the work as rapidly as circumstances will allow, they have resolved that it shall have a solid foundation by making increased provision for the education of officers and the training of common sailors. Concerning the education of officers, the memorialists recommended enlargement of the commercial navigation school at Tokyo, and that arrangements be made for complete courses of instruction in navigation and engineering. To make the instruction of the school thoroughly practical, it is suggested that training ships should be attached to it, so that the student may make voyages to different parts and gain experience in navigation.

Provision for the training of common soldiers, and State subsidies to ship-builders, are recommended. That the subsidized ship-yards shall be favored with orders for the construction of war-ships is part of the programme. The details of the scheme of State subsidies show a determination to assist and encourage the industry in every possible way.

The "Evoy" Jumper-Stay Compass.

THIS new marine compass rig is described in *The Marine Engineer* (Dec. 1), and it appears to be a very ingenious as well as meritorious improvement. It is stated that it has already gone into use on important vessels, among which are named the American liners, St. Louis and Paris; four vessels of the General Steam Navigation Company; the entire fleet of the Nautilus Company, of Sunderland; the Union R. M. S. Tartar; the City of Vienna, of the city line of Glasgow; and many other vessels, including yachts. Some of the masters of these vessels are said to speak very highly of the improvement, which is a "spirit compass" so designed and constructed as to allow of its being hoisted sufficiently high aloft to place it quite beyond the range of any local or induced magnetic lines of force due to the metallic construction of the vessel or its cargo, the mechanism being so arranged as to insure that, while the card swings absolutely free of all inductive influence when aloft, the first effort to haul the compass down instantly locks the card in place. As the card is not again freed, the correct reading so obtained is brought down to the bridge, or deck level, when comparison with, and correction of, the ordinary steering compass is readily and accurately made." The fanciful name, 'Evoy," is a contraction of the nautical phrase "heave ahoy." The engravings, Figs. 1 and 2, clearly illustrate the device.

"A jumper-stay running fore and aft from topgallant-mast-head to topgallant-mast-head has tackle rove from it, and secured to the deck in the manner shown. In its normal position the compass is down and locked, as in Fig. 1. When it is desired to take a reading, the card is unlocked by pulling back a trigger on the fore side of the bowl, and the cross frame containing the compass run aloft, as shown in Fig. 2. About three minutes suffice for the card to take up its correct magnetic position, after which the vessel is kept steady on her course, and, if rolling, a moment is selected when she is upright to haul the compass down to the bridge.

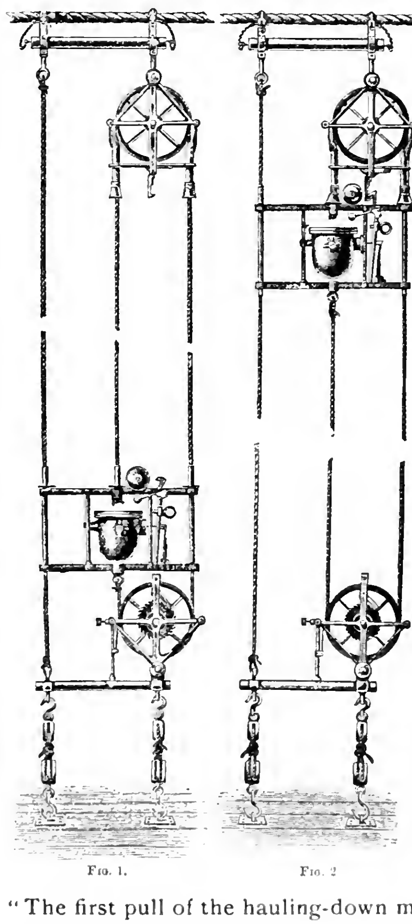


FIG. 1. FIG. 2

"The first pull of the hauling-down motion automatically liberates the internal locking gear, thereby clamping the card in its then position, and simultaneously causes the bell to ring aloft. The reading of the overhead compass, when so clamped and hauled down, is then compared with that which the standard steering compass showed at the moment the bell rang, and the difference, if any, is the deviation of the latter compass correctly ascertained apart from the aid of sun, moon, or stars, and as readily and accurately obtained during thick or foggy weather as in the brightest light.

"The use of this compass ensures, amongst others, the following advantages: a correct magnetic course is always ascertainable, regardless of the state of the weather or even during a dark night, and apart from azimuths, bearings, or calculations of any kind; as the compass is entirely removed from all metallic influence, there can be no deviation; the compass is correct in any latitude; a direct reading is taken on bridge or deck, without the aid of any only too frequently moisture-dulled glasses or reflectors; it is less expensive and more reliable than pole or masthead compasses, which in several lines of steamers it has superseded."

How to Fit Liners to Shafts.

THE danger of trusting wholly to the method of shrinking liners on shafts is well illustrated in the following narrative extracted from *Engineers' Gazette* for February. The narrative also illustrates the nature of many emergencies at sea which engineers are called to meet, as well as the readiness most engineers display in inventing remedies for temporary disabilities, when circumstances demand the exercise of this sort of talent.

A steam-ship, not named, recently sailed from Odessa for Copenhagen, but, after two days' bad weather in the Black sea, about an inch of water was discovered in the shaft tunnel near the engine room,—a place that had hitherto been perfectly dry. We will present the story of what followed in the narrator's own language.

"The chief sent the second engineer along the tunnel to the stern gland to try and ascertain the cause, and found the forward brass sleeve on the tail end shaft had become loose on the shaft, and had worked its way along a distance of six feet into the tunnel, against the aftermost shaft bearing, so that there was a rush of water into the tunnel corresponding with the space formerly occupied by the liner. The donkey pump was at once started on the aft-well, but the rush of water was found to be too great for the donkey to keep the well clear, although pumping full bore. The captain had been informed, and he sent ashore for a diver. By this time there were now four inches of water in the tunnel. The engineers collected a sack-full of hatch wedges, also two large quarter hammers, and went along to the stern gland and found water rushing in worse than before, the water being now about six inches deep. The wedges were driven in as close as possible to one another right round the shaft, and between the tail end shaft and the inside of the gland. At first great difficulty was experienced in getting the wedges to hold, on account of the force of water coming through the gland, but, after many attempts and failures, the wedges were firmly driven in right round the shaft. This stopped the flow of water, the donkey being now able to pump both the aft-well and the tunnel quite dry. The diver had just arrived, and, to make the job more secure, went down to the outer end of the stern tube and fixed some patent cement round the shaft and the end of the tube to keep the force of water out of the stern tube, thereby reducing the risk of the wedges being forced out into the tunnel. It may be mentioned that, after successfully stopping the water (which occupied two hours, during which time the engineers were working up to their waists in water, with hardly a scrap of clothing on), the engineer had to crawl along the tunnel shafting to get back into the engine-room again, the water being three inches below the top of the tunnel shafting. Next morning the ship was towed into Constantinople. During the night the engineers kept strict watch along the tunnel, the stern gland being visited every twenty minutes. On arrival in port, the after holds were discharged to tip the propeller out of water. Then, after removing the wedges, slipping the gland back, and drawing all the packing out of the stern gland, the liner was replaced, not in the exact original position, but projecting past the flange of the stern gland a distance of eight inches into the tunnel. This was done to allow of ⅞-inch tap holes being drilled through the liner, and about one inch deep into the shaft. Four of these holes were drilled at equal distances around the shaft at the foremost end of the liner, and the other two holes were five inches aft of the other four holes near the gland itself, screwed brass plugs being inserted and riveted over. This was considered sufficiently strong to hold the brass sleeve in its place. On arrival home, two new liners were fixed in the tail end shaft. On examination of the shaft, it was found that the original liners had not been contracted and then pinned on, but merely contracted on, which, in my opinion, should not be allowed. The stern gland and tunnel had been inspected on watch five minutes before the water was first discovered in the tunnel, and found to be running quite cool. The only reason for the liner coming loose appears to be that the shaft must have been a slack fit in the stern tube to commence with, and, during the heavy weather that was encountered, the shaft had been thumping in the tube, and so hammered the liner into the form of an oval. The subsequent working ahead and astern into Constantinople had helped, as it were, to screw the liner along the shaft, assisted by the force of water in the stern tube."

The Holland Submarine Boat.

ENGINEERING NEWS (March 12) quotes from the Baltimore *News* a description of this boat now under construction at the Columbian Iron Works of that city. The dimensions of the craft are as follows: Length, 80 ft.; maximum diameter, 11 ft.; displacement at surface, 118.5 tons, and totally submerged, 138. tons. The contract conditions require her, when running at full speed on the surface, to dive to a depth of 20 ft. within one minute after giving the order, and automatic apparatus prevents her from sinking below a fixed depth. The frame is made of angles 20 ins. apart, covered with ⅜-in. steel, with ½-in. steel armor plate on the top surface. For three-quarters of her length the shell is double, with the space between used for coal bunkers and water-ballast, and separated by water-tight bulkheads. Inside the shell, bulkheads of ¼-in. plate divide the vessel into seven compartments. Triple expansion engines will propel twin screws; coal will be used for fuel when running at the surface, and electric power when the boat is submerged. She will be provided with horizontal as well as vertical rudders and a vertical screw will assist her in descending. The contract speed is 15 knots per hour at the surface, with only her superstructure visible; with 3 ft. of water over the hull the speed is to be 14 knots, and 8 knots when completely submerged. Air compressed to 200 lbs. per sq. in. will supply the crew of 6 or 8 men when the boat is beneath the surface and the electric storage battery will supply light. The capacity of the storage battery is sufficient for a 6-hour run at 8 knots speed beneath the surface. All that appears above the upper surface of the boat is a small armored turret, and a smoke-stack. The contract price of this invention of Mr. John V. Holland is 150,000 dollars.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Marine and Engineering Journals—See Introductory.

*4091. On "Comparison of Mechanical Draughts." John Thom (A paper read before the Inst. of Engs. and Shipbuilders in Scotland. Recounts observations made during voyages in ships each using a different system of mechanical draught with conclusions arrived at. The four systems discussed and compared are (1) the Howden system, (2) the British admiralty system, (3) the Ellis and Eaves system, and (4) the closed ash pit system. The paper is based upon careful notes taken during these voyages). Eng's Gaz-Feb. 4000 w.

*4092. A Loose Liner on a Tail End Shaft. Mac Hine (Illustrates a danger that may arise when liners are merely shrunk on and not also attached by pins). Eng's Gaz-Feb. 800 w.

*4093. Countersinking in the Shipyard. Robert H. Muir (Read before the North-East Inst. of Engs. & Shipbuilders. A detail which has received less attention in the ship-yard than almost any other. The object of the paper is to draw out information, and to arrive, if possible, at some agreement upon a correct angle of countersink for different sizes of rivets and thickness of plates used in ship-yard work). Eng's Gaz-Feb. 1300 w.

*4094. The D'Allest Water Tube Boilers

(Comparative tests of new and old style D'Allest boilers. The description of the tests is by Mr. D'Allest). Eng's Gaz-Feb. 1100 w.

*4103 Sir E. J. Reed on the Question of Ship's Side-Lights (Defence of an order of the Marine Department of the Board of Trade, issued Jan., 1893, prescribing an angle of four degrees as the largest at which any part of a ship's side light should pass the screen and cross the line of the ship's advance The severe criticisms to which this order has been subjected are answered). Steamship-Feb. 1700 w.

*4105. Transatlantic Passenger Traffic (Editorial. Review of official returns for 1895). Engng-Jan. 31. 800 w.

*4107. The Development of the Japanese Mercantile Marine (Interesting correspondence portraying the remarkable development of the shipping interest. No less than seven new lines are now talked of. The system of State subsidies is recommended by the Tokyo chamber of commerce). Engng-Jan. 31. 1800 w.

*4108. French Shipping Bounties (Unsatisfactory increase in the number of French commercial steamers, notwithstanding the government pays more in bounties than any other country. Editorial). Engng-Jan. 31. 1100 w.

4144. Water-Tube Boilers. Ill. W. T. Bonner (Paper read before the Mining Assn. of Quebec. Setting forth facts which the writer believes to be proof of the correctness of the system). Can Elec News-Feb. 4200 w.

*4298. Patent Marine Salvage Appliances (Illustrated description of a variety of modern appliances for raising sunken vessels and recovering submerged cargoes, with methods of using the same). Marine Eng-Feb. 1. 1100 w.

*4306. A Practical Formula for Thrust Bearings. J. Husband (This formula is based upon the assumption that the whole area of the collars on the screw shaft is not in contact with the bearing surface. The investigation from which the formula is derived is also presented). Prac Eng-Feb. 7. 200 w.

*4386. Calculation of Horse-Power for Marine Propulsion. Thomas English (The calculation proceeds from the basis of the resistance of a given vessel at the speed desired. Froude's method of ascertaining resistance is approved and adopted, as is also the principle that according to Froude's method it will always be possible to make two models on such scales that the same absolute speed will for one of the models, correspond with that of a ship which has been tried at sea, and the other with that desired for a proposed ship. An apparatus whereby the delicate dynamometrical apparatus ordinarily used with a model tank may be dispensed with. The mode of using it is also described). Ind & Ir-Feb. 14. 1300 w.

4397.—$1.25. Contract and Screw Trials of the U. S. S. Katahdin. F. C. Bieg (An exhaustive description with numerous illustrations of machinery, etc., and tabulated data derived from the tests). Jour Am Soc of Nav Engs-Feb. 5000 w.

4398.—$1.25. Contract Trial of the Machinery of the Texas. T. W. Kinkaid (Complete description with numerous illustrations of machinery, etc., and tabulated data resulting from the tests). Jour Am Soc of Nav Engs-Feb. 3300 w.

4399—$1.25. Test of a No. 4, Type B (Horizontal) Evaporator. G. W. Baird (Illustrated description of tests of an evaporator of the kind named, designed for the Nashville, U. S. N). Jour Am Soc of Nav Engs-Feb. 700 w.

*4412. Salvage Tug for the French Navy (Illustrated detailed description). Engng-Feb. 14. 800 w.

*4413. The Training of French Naval Officers (Editorial. Historical sketch from the initiation of the project, to its final adoption, and its general value to French marine progress, with an outline of the scheme of training it will offer). Engng-Feb. 14. 2500 w.

*4416. Telemeters and Range-Finders. Profs. Barr and Stroud (Paper read before the Inst. of Mech. Engs. Confined to a description of the range finder now used in the navies of Britain and other countries, and to another smaller hand instrument which is much more portable and much simpler than the former, the object apparently being to exploit the latter). Engng-Feb. 14. Serial. 1st part. 3500 w.

*4552. Engines of Torpedo Boat Destroyers "Handy," "Hart," and "Hunter" (Illustrated detailed description). Engng-Feb. 21. 1100 w.

*4554. Water-Tube Boilers for the Dutch Navy (Illustrated description and an account of tests). Engng-Feb. 21. 1200 w.

†4577. The Marsden Corn-Pith Cellulose. Lewis Nixon (A simple explanation of some of the phenomena connected with the behavior of vessels under various conditions, is followed by a discussion of the use of cellulose as a water excluder in armored vessels as related to buoyancy and stability of vessels at sea). Jour Fr Inst-March. 3300 w.

*4686. Rates of Speed and Rates of Freight (Their relation is ably considered. The limit of 19¼ knots, with 7 days limit of time for remaining in port is fixed as the speed for maximum profit, for a ship of 10000 tons burden. Above this speed profits rapidly diminish). Eng, Lond-Feb. 28. 2800 w.

*4688. Lengthening the Cape Mail Steamer Scot (Describes the lengthening of a steamer by an addition of 50 ft. The vessel is cut in two and the addition to length is made amidships. Illustrated by diagrams showing the method). Eng, Lond-Feb. 28. 300 w.

*4689. Modern Warships and Dock Entrances (Descriptive, with engravings showing the widest and the least, of the existing and proposed entrances). Eng, Lond-Feb. 28. 1000 w.

*4692. Boiler and Engines of the "Santo Antonio" (Illustrated detailed description). Engng-Feb. 28. 1400 w.

*4710. Quadruple Expansion Engines for Lake Service. Walter Miller (Economy secured by the adoption of high steam pressures, and quadruple expansion on the lake marine since 1855. Discussion). Jour Assn of Engng Soc-Jan. 6000 w.

MECHANICAL ENGINEERING

High Admission Requirements in Engineering Schools.

AN editorial in *American Machinist* (Feb. 13) criticises the modern tendency to increase the standard of requirements for admission to engineering schools. This is regarded as the most unfortunate development of the educational system in these schools, and it is objected to on the following grounds.

" High admission requirements are supposed to test the ability of the applicants, and to sift out those who are least capable of pursuing the course of study with profit. In point of fact, they do nothing of the kind. Instead of testing the abilities of the student, their real effect is to test his opportunities, and to sift out those who, by reason of location, occupation, or lack of means, have been denied access to the best preparatory schools. We do not for a moment imagine this to be their object, but it is undoubtedly their effect. The result is a new illustration that 'to him that hath shall be given, and from him that hath not shall be taken even that which he hath.'

" The usual explanation of their course by engineering faculties is that the high requirements are necessary to keep down the number of applicants which otherwise overwhelm the schools. Most of the schools admit the necessity for shop experience by providing it in their school work. Now, if it is desired to keep down the number of applicants, how would it do to require them to have served an apprenticeship in a machine shop? We do not doubt this would be still more effective than the present plan with a large number of the present class of applicants. Or, if this is considered too revolutionary, what is to prevent an arrangement by which previous shop experience should offset some of the more advanced of the present requirements,—the time which the present class of students devote to shop work being given by the new class to the preparatory studies in which they would be deficient?

" In the old days, it was possible for one who had spent considerable time in the shops to still pass the then comparatively modest examinations for admission ; and a good proportion of the students were of this class. If Professor Sweet (the most successful instructor, in proportion to his opportunities, that the engineering schools have seen) were asked, we do not doubt that he would testify that such students formed the very best timber he ever had, whereof to make engineers.

" It should be noted that the course suggested would assist in solving that other and still greater problem,—in fact, greatest problem in education, and one which we have always with us,—namely, self-support by poor students. A student in possession of a trade on entering college could use his vacations profitably in providing himself with funds ; and the policy outlined, if adopted, would give heart to many who can now see no means of educating themselves.

" It will be objected, of course, that the plan proposed would interfere with the curriculum, and introduce confusion in place of order. The average college professor is, of course, a worshipper of system as system ; but the man of affairs knows that a system which interferes with results is, in fact, mere red tape, and should be treated with corresponding contempt.

" A conspicuous illustration of our remarks is Cornell University, whose founder gave not only his fortune, but his life, in the belief that he was founding an institution for the benefit of the class from which he himself came, and for which we are here pleading. Moreover, this institution is largely endowed with public funds, which would seem to increase its obligations to the general public. The entrance examinations could not be better planned if they were intended to exclude students from the shops, and, so far from the founder's plans being carried out, they have, in fact, been seemingly forgotten. Cornell University to-day does little more than duplicate facilities for education which exist in ample degree without it. It is naturally becoming more and more a school for the education of rich men's sons; and testimony is not lacking that a spirit of aristocracy is springing up among its students, in place of the old spirit which illustrated democracy at its best. Meanwhile it aspires to the position of a State University, the recognized head of the State system of instruction, and asks for more public money. Is it surprising that it does not get it?"

The force of the arguments we have quoted can not be denied. We should like to see a competition between two engineering schools,—one requiring shop practice as a qualification which, with other qualifications attainable by ambitious boys who work in shops, should be sufficient for matriculation, and the other requiring the qualifications now demanded for admission to either Cornell or Lehigh University,—so that the merits of the two systems could be tested by the results shown in the active lives and achievements of the graduates of the two institutions respectively. We have little doubt that in the end the former would demonstrate its superiority.

It is only fair to add that the statements made by *American Machinist* with reference to Cornell University were met with a courteous denial from Professor R. H. Thurston, printed in the same paper (March 5). A review of Professor Thurston's communication is reserved for our May number.

Reamers Without Clearance.

An accomplished American mechanical engineer, Mr. T. R. Almond, of Brooklyn, N. Y., writes to *American Machinist* (Feb. 20) on the subject of reamers without clearance, describing a practical method of making such a reamer and one that can be kept sharp without altering its diameter at the cutting edges. As this subject is of importance in mechanical construction, we gladly aid in disseminating the information thus presented.

After specifying the importance, in much mechanical construction, of limiting variations to those no greater than one-quarter of one-thousandth of an inch, of the production of holes that vary in size no more than a fraction of an inch named, and of the advantages resulting (economical production and interchangeability) from such a degree of accuracy, he premises that, after having fixed upon the sizes of holes, a good gage and a good reamer will be needed to get these sizes, and he gives directions for making both implements.

"The first thing necessary is to fix upon the size of the hole best suited to the purpose, so as to avoid future changes. You will then be warranted in making a standard, hardened and ground steel plug-gage of the size required. If this were for my own use, and the size of hole required were $1\frac{5}{16}$ inch, the plug I would make 8 inches long,—4 inches for ground part at one end, $2\frac{1}{2}$ inches of somewhat reduced diameter between the ground and knurled ends, where name, size in thousandths, and other matter required, would be stamped before hardening. Having one such gage, you will not perhaps require another of same size in a lifetime, the amount of wear being practically nothing.

"The reamer is the next thing of importance, and decidedly the most interesting. The possession of the two virtues, faith and hope, may be required to enable you to put an ordinary straight-fluted jobber's reamer into shape for the purpose. Assuming the size required to be $1\frac{5}{16}$ inch, the reamer to be found on the market is of no use, unless perhaps you should have the good fortune to have one about .010 above size. This should be ground to the required size in lathe or universal grinding machine, as you would grind any cylindrical piece of work, great care being taken to let the wheel cut very little as you approach the required size. When finished, each tooth will be cylindrical in shape, back of the cutting edge. After the cutting edges have become dull by use, they may be sharpened by careful grinding on the face of the tooth. This can be done by hand, if the wheel be true, the hand steady, and the grip taken well towards the back end or shank part of the reamer, the face of the tooth being applied to the under side of the wheel of an ordinary every-day emery-wheel stand. A little practice will be required to do this nicely, and it is well worth the trouble, as in this way many dull reamers may be sharpened without changing their size.

"The manufacturers of reamers usually bring the teeth up to a sharp edge, leaving no cylindrical portion back of the edge. This, for cast iron, is a mistake, as the edges soon become worn and lose their size. It is true that such reamers will cut more freely; but, as absolute size is the thing desired, they answer for a short time only. I have had a reamer in use for several years, which makes a hole so close to the gage that a slight difference of temperature—say 20 degrees—between it and the work is quite appreciable in the fit. This reamer has been used on a good quality of cast iron only, and not allowed to come in contact with scale.

"The holes are first bored to size, leaving but two or three thousandths for the reamer to take out. Tools of this description should be made of the very best quality of steel, and left as hard as possible. After being hardened, they should be heated to a degree just short of showing any color. This should be done before the tool is ground. If done after the grinding process, it will, in all probability, no longer be true. In other words, a piece of good tool steel, made as hard as possible and then ground true on centers, will, in all probability, upon being reheated to 300 or 400 degrees, change its shape or become out of true."

Aluminum Alloys to Replace Brass.

MACHINERY for February quotes from the *Aluminum World* a description of new aluminum alloys, which, it is claimed, may replace brass in castings, and which are made by directly reducing the metals in reducing pots, with special precautions against oxidizing and occlusion of gases The new metal, if in all respects as described, has promise. We quote enough of this description to show what is claimed.

"The alloys have a specific gravity of between 3.0 and 3.15, where brass has a specific gravity of from 8.21 to 8.44; the brasses being 2.57 to 2.70 times heavier than the aluminum alloys. These alloys contain a larger proportion of aluminum than the brasses do of copper; and, when the selling price of the brass ingot is multiplied by its factor of relative weight, the aluminum alloy is now being sold at as low, and in some cases at a lower price, bulk for bulk. This means a great deal, not only in the utilization of aluminum in the arts, but in the application of a vast number of the engineers' constructions, and warrants the careful study of the relative merits of the two sets of alloys. The aluminum special casting alloys which now sell in ton lots of ingots at from twenty to twenty-seven cents per pound, according to quality, are relatively cheaper for the manufacture of casting than the brass now in general use for this purpose. In a general way, their composition is from seventy to seventy-five per cent. of pure aluminum, together with zinc, copper, nickel, manganese, iron, and, in some cases, with titanium, chromium, or tungsten. These alloys have as little shrinkage as ordinary brass, and can be re-melted in plumbago crucibles and cast with the same facility as can brass, and are now becoming largely used in the leading brass foundries of the country.

"The bronzes, under which name are included the principal alloys of copper and tin, together with a few special compositions such as phosphor-bronze, aluminum bronze, manganese bronze, etc., are all higher in cost of manufacture than the brasses, and are now more expensive than the cheap special casting alloys of aluminum, and are at least equal in expense with the nickel and copper-hardened alloys which contain ninety per cent., and more, of aluminum. The cheapest of the bronzes, containing from one to even as high as ten per cent. of zinc, and with small percentages of lead and iron, cost at least twelve cents per pound and range as high as fifteen cents per pound in ingots. These alloys have a tensile strength of from 46,000 pounds to 50,000 pounds per square inch, in hard-rolled sheets. In castings, brass has a tensile strength of from 18,000 to 30,000 pounds per square inch, with an elastic ratio of from twenty-five to thirty-five per cent. The hardened aluminum alloys compare favorably in tensile compression and transverse strength with brass alloys. The special hard casting alloys containing over seventy per cent. of aluminum and having a specific gravity of 3.15 are furnished by the Pittsburg Reduction Co., with a guaranteed tensile strength of from 25,000 to 30,000 pounds per square inch, and with an elastic ratio of over forty per cent."

Books on Steam Engineering.

AN editorial on this subject (*The Electrician*, Feb. 21) treats of what it styles a *renaissance* of superheating in steam practice, and expresses the view that, notwithstanding there are disadvantages which weigh more or less against its advantages, the former "are not so formidable at the present day as they were in earlier times." At the same time it is noted that neither pressure of steam or the extent of the superheating in former years ever nearly approached the practice of the present day in these particulars. The introduction of mineral oils which have replaced animal and vegetable oils and fats for engine lubrication has had much to do with lessening the troubles that once attended superheating. It is concluded that "we are on the eve of a very considerable extension of the use of superheaters in steam-engine practice." This increased use of superheaters follows naturally upon the growing use of water-tube boilers.

A new work on steam engineering,* written by an ex-president of the International Society of Mechanical Engineers (who is said to have been a former supervising inspector of steam vessels for thirteen years), having recently come to our desk, an examination of this book for the latest information upon superheating naturally suggested itself to us on reading the editorial referred to. In a large octavo volume of 803 pages, with such a title as "Library of Steam Engineering," one would expect to find something relative to superheating, which dates back to Trevithick's time, and something also relative to water-tube boilers, which have been in successful use on land for more than two decades, and have also been used for marine purposes with such success that their increased future use for marine propulsion is certain. The book has a table of contents for each chapter and an index. We have vainly sought by these aids to find anything relating to superheaters, or to water-tube boilers. "Tubulous boiler" is also a term much used to distinguish water-tube boilers from fire-tube boilers, but it is not in the index of this book. Seeking an explanation for these omissions in the preface or introduction, we confess to surprise at finding in the first sentence of the preface that "the aim of the author has been to produce a book that would embrace the entire field of the science of steam engineering." In the second paragraph of the preface it is stated that the further purpose of the author has been "to embrace, in the same volume, all the information necessary to enable engineers to pass a most successful and rigid examination by inspection officers; to enable engineers to fill positions of inspectors; to become experts in making evaporative and calorimeter boiler tests, and indicating steam engines; adjusting valves and valve-gear, and draughting plans and specifications for the construction of steam-boilers; in short, to become proficient in all the arts and sciences (?) of steam engineering, stationary, locomotive, and marine." We submit that these assertions entitle us to look with confidence to the text of the work for something relating to any appliance more or less used in steam practice for periods of from say twenty to fifty years. Somewhat discouraged, we looked in the chapter on calorimeter tests, thinking something might be found about superheating (upon which accessible literature is quite abundant), and we did find the following sentence.

"If the steam is super-heated, it will show a greater number of heat units per pound for a given pressure than is con-

* A LIBRARY OF STEAM ENGINEERING. By John Fehrenbach, M. E. The Ohio Valley Co. Cincinnati, 1895.

tained in the standard steam as shown in the table." This is all we could find about superheating in the entire book. The list of engravings is a long one, and is not alphabetically or systematically arranged; but we groped through it, hoping that we could there find some reference to superheaters, or water-tube boilers, or both. We found none, and so are constrained to say that our first attempt to use the book was very disappointing. However, any one who has tried to become familiar with the general run of books annually added to the literature of steam engineering has probably had many similar experiences. In many cases this is not because the books do not cover some part of the ground sufficiently well, but rather because what is claimed for them in title-pages, prefaces, and introductions is more than the contents will justify. And there are many books on steam engineering which seem to have been issued simply because their publishers wanted books of this kind to sell. It is easy to make a book where the work involves little labor beyond that of compilation; but to make a *really good* book—one that shall prove a valuable addition to the already large list of good books on steam engineering—requires more than skilful compilation from pre-existing books. Some books of this kind come under our notice which contain absolutely nothing not found in much better form in other books always contained in any library of steam engineering literature, even if it be a small one. Why are such books published and advertised? They are merely "made to sell."

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At Last—Actual Flight by Human Kind.

HUMAN flight is at last a feat accomplished. To be sure, the beginning is a clumsy, imperfect flight, ridiculously imperfect as compared with the flight of the pigeon, the swift, or of the heavier birds, like wild geese or ducks that move far over our heads toward southern feeding grounds, where they are eagerly sought by presidential sportsmen; but *it is flight*, actual, though as yet not very far removed from the mere potential.

A writer in *Nature* (Jan. 30) says that Herr Otto Lilienthal's experiments have, up to the present, shown that, by means of such apparatus as he employs, fairly long flights may be indulged with perfect safety, provided the operator does not attempt to do too much at the beginning, but contents himself with mastering the first elements of sustaining his equilibrium. The following abstract of the article gives a fairly good representation of the situation.

Falls must be expected in preliminary trials, until the operator becomes accustomed to the many new conditions, and before he learns to master them instinctively and automatically. In other words, it requires considerable practice to fly with the Lilienthal apparatus.

For instance, similar difficulties have to be contended with when learning to ride a bicycle. The beginner is at first unable to keep his equilibrium, and so wobbles here and there with the loss of much power, until he eventually finds himself on the ground. This is simply because he is doing something unusual, and is not accustomed to the new conditions. An adept rider, on the other hand, never thinks of the possibility of falling, and quite unconsciously keeps his equilibrium without any exertion or loss of power. So it is with this sailing machine, and it is only with practice that the required head can be obtained and success assured.

The experiments have been extended to a new form of machine, employing what is claimed to be a new principle. The idea consisted in using, instead of one large framework covered with some light material, two smaller ones, placed parallel, one above the other. These, of course, would, when sailing through the air, have a similar lifting effect; but, besides affording a simple means of increasing the sailing area without adding to the breadth of the machine, they would decrease very considerably the difficulties, referred to above, with respect to the management of the center of gravity.

On this principle Otto Lilienthal constructed his new double apparatus. Each separate surface has an area of nine square meters; thus it is possible to employ the very large carrying surface of eighteen square meters with a breadth of only five and a half meters. The upper surface, which is placed at a distance of about three quarters of a wing-breadth above the lower, proves in no way a disturbing factor in the machine, as might at first be supposed, but develops simply a vertical lifting force. It may be remarked that this double-surface machine is managed in exactly the same way as the single-framed one. The upper surface is fixed rigidly to the lower one by means of two rigid stays, the whole surface being held in position by means of thin wires.

With the new apparatus, Otto Lilienthal has already found that a step in the right direction has been made. The energetic movement of the center of gravity, and the consequent more safe management of the apparatus, has led him to practise in winds blowing at times over ten meters per second.

"These experiments," he says, "have given the most interesting results that I have arrived at since I began." With a wind velocity of six to seven meters per second, the sailing surface of eighteen square meters carried him against the wind in nearly a horizontal direction from the top of the hill, without even having to run at the start, as is generally necessary. More interesting still is it to learn that, with stronger winds, he allows himself to be simply lifted by the wind from the hill-top, and sail slowly against it. The side motion is so strong at times that the operator has to alter the position of his center of gravity considerably to retain his equilibrium.

As experiments have shown, the sailing path is directed strongly upwards by increasing wind force, and this fact causes the operator sometimes to be higher in the air than he was at his original starting-point. In this position his apparatus has occasionally come to a stand-still; whence the following interesting statement:

"At these times I feel very certain that, if I leaned a little to one side, and so described a circle, and further partook of the motion of the lifting air around me, I should sustain my position. The wind itself tends to direct this motion; but then it must be remembered that my chief object in the air is to overcome this tendency of turning to the left or right, because I know that behind and under me lies the hill from which I have started, and with which I would come in rough contact if I allowed myself to attempt this circle sailing. I have, however, made up my mind, by means of either a stronger wind or by flapping the wings, to get higher up and further away from the hill, so that, sailing round in circles, I can follow the strong uplifting currents, and have sufficient air space under and about me to complete with a safety circle, and lastly to come up against the wind again to land."

It may be remembered that Lilienthal has previously employed some mechanical aid, such as the flapping of the wings; an illustration of the apparatus so arranged was given in an article in *Nature*, vol. li., p. 178. Perhaps he will apply the same arrangement to the lower framework of his present apparatus, and thus accomplish the end he is wishing to attain.

One can quite understand that sailing against the wind is one thing, and with it another. In the latter case, since the framework is inclined slightly upwards in the direction of motion, the wind would meet the sailing surface from above, and shoot the operator, arrow-like, to the ground if he were unable to come up to the wind again quick enough. That such circle sailing will be successfully accomplished seems certain, but the first attempts may prove rather rough. Herr Lilienthal has thus shown that, by means of his new apparatus, a very close approximation to flying has been attained.

Should he, however, find that the accomplishment of circling is attended by any great difficulty,—and there appears no reason why it should,—then an important step will have been made, and the future of development of this *Fliegesport* will depend almost directly on the *Fliegepraxis*.

It is interesting to notice that in America this Lilienthal method is about to be tested. In the British Isles Herr Lilienthal has already a follower in Mr. Percy S. Pilcher, of Glasgow University.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

The Machine Shop.

4166. Hints on Machine Design. Charles L. Griffin (An excellent practical article. Young draughtsmen will do well to read these hints). Am Mach–Feb. 13. 700 w.

4351. Reamers without Clearance. T. R. Almond (Practical hints upon the production of reamers very accurately sized, the keeping of these tools in order and upon their use). Am Mach–Feb. 20. 700 w.

4465. Oil as a Fuel for Core Ovens. H. Hansen (Paper read before the meeting of the Western Foundrymen's Assn. Discusses a method of baking cores wherein a number of oil fuel fires in the oven are maintained, thus securing a uniformity of product alleged to be unattainable otherwise). Foundry–Feb. 2800 w.

4466. Molding Sand and its Preparation for Mold and Cores by Old and New Methods. A. E. Outerbridge (A practical discussion of the selection of molding sand and methods of mixing, with a description of Sellers' sand mixer and sifter). Foundry-Feb. 2300 w.

4509. Hints for the Draughting Room. W. S. Huyette (Practical suggestions of value, particularly with reference to keeping records of constructive changes). Mach–March. 1200 w.

4510. Itemized Cost of Castings. Robert Grimshaw (A system of cost accounting for foundry work as carried out in the shops of a well known leading manufacturing establishment). Mach–March. 1400 w.

4513. About Belts—Theory and Rules for Belting. Thomas Hawley (Extract of lecture in Lowell Free Course, at Wells Memorial Inst., Boston. Contains a very thorough résumé of theoretical and practical information upon the subject). Bos Jour of Com–Feb. 29. 3500 w.

4617. Cross-Section Paper in the Shop. William O. Webber (Possibilities of its usefulness unrealized by the mechanical engineer and draftsman in ordinary metal-working establishments). Am Mach–March 5. 800 w.

4618. Molding Cone Pulleys. George O. Vair (Two different plans are illustrated and described). Am Mach–March 5. 650 w.

Steam Engineering.

*4084. Artistic Engine-Room Interiors. Ill. E. T. Adams (Pointing out the tendency to heed the esthetic sense in the designing of engine-rooms, and describing several plants notable in this respect). Eng Mag–March. 2300 w.

*4101. The Schmidt Superheated Steam Motor and Boiler (Illustrated detailed description). Eng, Lond–Jan. 31. 1200 w.

4165. Behavior of a Fly-Wheel Governor under Sudden Changes of Load. Walter Ferris (Illustrated detailed description of apparatus and method employed in an experimental investigation of this important matter. The article is unusually interesting and instructive). Am Mach–Feb. 13. 1800 w.

4209. The Safe and Economical Management of a Steam Plant. Charles H. Garlick (The question is discussed from the practical side purely). Safety V–Feb. 3500 w.

4210. Testing Steam Boilers. C. A. Collett (A practical discussion of methods of ascertaining the safe or unsafe condition of steam boilers). Safety V–Feb. 1700 w.

*4228. Notes on Steam Superheating. William H. Patchell (A paper read before the Inst. of Mech. Engs. Historical, theoretical, and practical, with tabulated data of tests of boilers with and without superheaters). Col Guard–Feb. 7. 4000 w.

*4305. Graphic Methods of Engine Design. A. H. Barker (Will discuss the application of graphic methods to the design of engines in which these methods are often more rapid and satisfactory than mathematical calculations). Prac Eng–Feb. 7. Serial. 1st part. 3500 w.

*4428. Mechanics of the Shaft Governor. John H. Barr (A consideration of the principal points necessary to be observed in the successful design of any of this class of governors). Sib Jour of Engng–Feb. 6000 w.

*4429. Steam. De Volson Wood (Abstract of a lecture delivered before the students of Sibley College. The consideration of the subject is from the scientific and thermodynamic standpoints). Sib Jour of Engng–Feb. 2500 w.

*4562. Notes on Steam Superheating. William H. Patchell (Paper read before the Inst. of Mech. Engs. Historical. Describes a great variety of devices for superheating, from Trevithick's time up to date, and gives in tabulated form the data obtained from the most modern practice in superheating. An excellent paper). Eng, Lond–Feb. 21. 6000 w.

*4563. British Types of Land Boilers (History of land boilers from the time of Desagulier (1718) to date. An interesting and instructive paper read before the Cleveland Inst. of Engs. at Middleborough, Eng., with discussion). Eng, Lond–Feb. 21. 4400 w.

*4584. The Renaissance of Superheating (Editorial. Discussing the increasing practice of superheating steam, states the advantages gained by the practice, expresses the opinion that it is now on a more permanent basis than at any other time since Trevithick invented and used it). Elect'n–Feb. 21. 2200 w.

4603. The Massachusetts Inspection and License Law (A critique. It is maintained that under this act, a man who in a plant of less than 150 h. p. would be unable to get up steam and start the engine, might yet, under this law, be granted a first class license). Lord's Mag–March. 2200 w.

4660. A New Self-Cooling Condenser (This condenser is designed as a substitute for the hitherto costly and bulky condensers used in locations where water supply is very expensive. It is thought to be as efficient as former appliances, while at the same time its bulk and cost are less). Eng News–March 5. 900 w.

*4685. A Curious Old Steam Engine (Engraving of a free hand sketch, accompanied by a description of a Watt Engine at Soho foundry, designed by James Watt during his father's lifetime, and which is estimated to be at least 75 years old). Eng, Lond–Feb. 28. 1000 w.

*4701. Types of Land Boilers. Edward G. Hiller (Paper read before the Cleveland Inst. of Engs. The first part is chiefly historical beginning with the development of steam-boilers in the time of Savery). Prac Eng–Feb. 28. Serial. 1st part. 4500 w.

4714. The Continuous Use of Condensing Water (Illustrated detailed description of a new apparatus for this purpose, installed in the 2d District Station of the Edison Electric Illuminating Co., Brooklyn, N. Y.). Power–March. 2200 w.

4715. The Carbonizing of Wooden Lagging on Cylinders and Pipes (Review of an investigation carried on by the Boston Manufacturers' Mutual Fire Insurance Co. The results are important. It is found that fire hazards are increased by the use of this kind of lagging). Power–March. 1600 w.

4716. Experiments Showing Circulation in Water Tube Boilers (Review and illustrated description of experiments carried out at the works of Yarrow & Co., London, and the results). Power–March. 2500 w.

Miscellany.

4169. High Admission Requirements in Engineering Schools (Editorial. A tendency toward a too high standard of scholastic requirements as a condition of admission into engineering schools is regarded as unfortunate, and as likely to lead to ill effects). Am Mach–Feb. 13. 800 w.

4170. Reliable Approximations versus Guesswork (Editorial. Directed to showing that the approximations of a well matured judgment may often be valuable, as compared with more elaborate calculations, to which they may be valuable checks). Am Mach–Feb. 13. 900 w.

4171. The Uses and Advantages of a Public Supply of Compressed Air. Frank Richards (The many applications to which compressed air, kept in store in cities, to be drawn upon by consumers, could be made useful, is the subject to be considered. The first number appears to be chiefly introductory to the main purpose). Am Mach–Feb. 13. 1000 w.

4175. Japanese Clocks and Pocket Sun Dials (Illustrated description, translated from *La Nature*). Sci Am–Feb. 15. 1800 w.

4177. Some American Motor Carriages (Illustrated description). Sci Am–Feb. 15. 1800 w.

*4198. Recent Developments in Gas Engines. Ill. (Abstract of paper by Mr. Dugald Clerk, read before the Inst. of Civ. Engs., England. The writer reviews the great advances that have been made in gas engine construction, and concludes that it will yet be applied to railways and ships, just as it is now used in factories). Elec Rev, Lond–Feb. 7. 1300 w.

4304. Coal Pockets for a Manufactory (Illustrated detailed description). Eng Rec–Feb. 15. 700 w.

4350. Strength of Shafts. Charles L. Griffin (A diagram for easily determining the diameter of shafts subject to simple bending or twisting, or to both combined). Am Mach–Feb. 20. 200 w.

4436. Wave Motor Experiments (Illustrated description of Gerlach Wave Motor, and of a partially successful experiment with it, soon to be repeated under more favorable conditions). Jour of Elec–Jan. 1. 1800 w.

4440. The Manufacture of Metallic Tubes by the Boulet Process (Detailed illustrated description of processes of making butt-welded tubes, lap-welded tubes, Mannesmann tubes, and tubes by a new process called the Boulet process). Sci Am Sup–Feb. 29. 2900 w.

4477. Recent Developments in America of Mechanically-Propelled Road Carriages (First part is a general review of progress in the art, with illustrated descriptions of various carriages of the class, and will be followed by more or less detailed descriptions of other examples of this kind of vehicles). Eng News–Feb. 27. Serial. 1st part. 3500 w.

*4506. English Steam Carriages. Ill. William Fletcher (The leading feature of this article is the discussion of weight as related to the different purposes for which this class of vehicles is adapted). Mach, Lond–Feb. 15. 1500 w.

4507. Strength and Wear of Gear Wheel Teeth. Bell Crank (A critical review of the subject with reference to recent articles on the same subject which have appeared in this paper). Mach–March. 1300 w.

4508. Helical Gearing Cisnarf (Practical information supplementing the theoretical information given in text-books). Mach–March. 1500 w.

4604. Gas Motor Crane. C. Jimels (Translated from *Le Génie Civil*. Illustrated detailed description of an installment erected by the Parisian Gas Light and Heating Co. Handles 1200 kilos of coal at each load, lifting it 21 meters, together with the bucket which weighs 500 kilos, at the rate of 30 meters per minute). Pro Age–March 1. 1800 w.

4621. Entrance Requirements, Endowment and Scholarships at Cornell University (Letter to the editor from R. H. Thurston, with editorial remarks). Am Mach–March 5. 3800 w.

4657. The Possibilities of Mechanically-Propelled Vehicles for Common Roads (Editorial. The subject is discussed in relation to the questions: (1) to what sphere of usefulness are such vehicles best adapted? (2) in what direction had we best work in design and construction to fulfill the conditions of desirable, efficient and safe modes of conveyance? It is thought the motor carriage will be of greatest use when applied to mercantile purposes, for delivery, etc., of goods in cities, for which purpose long distance capacity and high speed are not needed). Eng News–March 5. 3200 w.

MINING & METALLURGY

The Education of Metallurgists.

TECHNICAL education in the United States has received so much unsolicited encouragement, both from the demand for technical graduates, and from State appropriations, that those not directly interested do not appreciate our relative educational position among nations, and take the whole situation as a matter of course—as an example of our enterprise. It is only when we compare the elaborate and excellent equipment of our laboratories and the strictly technical character of the instruction with those of our principal competitors in the metallurgical industries, that we begin to realize our own status and to find a reason for the rapid development of our iron, steel, copper, and metal-refining industries. Mr. Thomas Turner, in a paper before the South Staffordshire Institute of Iron and Steel Works Managers, which was published in the *Iron and Steel Trades Journal* (Feb. 15), says:

"The most notable fact in the history of the iron trade for the last fifteen years has been that, while at the beginning of that period England had an undoubted supremacy in the iron trade of the world, America has become the premier iron-producing country, while Germany runs the United Kingdom very closely for the third place; and, further, that, while these two countries have thus enormously increased their output, the produce of our own country has diminished instead of increasing. It is, perhaps, scarcely necessary to point out that in Germany and America more attention has been devoted to technical construction in metallurgy and other cognate subjects than in any other country in the world. The work of Germans in this respect is too well known to need further reference, while the advances in the provision of higher education in America have been, during recent years, most remarkable. Mr. Mundella has recently reminded us that in 1883 there were in Germany 24,000 university students against 5,500 in this country. The fees in Germany were about 30s. per annum as against about £30 in the United Kingdom. No doubt, in the interval that has since elapsed, we have made much progress, but there is still need for extended higher training at a moderate cost, and for this purpose increased State aid to university colleges is necessary. Apparently what is wanted is scientific and manual training for the men, together with the very highest technical instruction in metallurgical science for the masters and others who have to lead."

The author here examines into the work of the various institutions in England which include metallurgy in their curriculum. He concludes that the lack of instruction for workingmen is principally due to the apathy of the men themselves, and that, as soon as the want is made known, the means for such instruction will be supplied. For higher instruction he considers that the laboratories now being used are not adequate, and that the instruction abounds in superfluous subjects which make the graduate more of a scientific than a technical man, and therefore usually a disappointment to the iron works managers.

"Until metallurgical teaching is placed on the same basis as, say, that of chemistry or physics, with an independent professor, having a seat upon the board of studies with properly-equipped laboratories, and with efficient apparatus, comparatively little progress can be anticipated in the university colleges. I venture to submit that in the United Kingdom we at present are, or at all events soon shall be, in as good a position to educate our workingmen in metallurgical subjects as are our competitors, but that the provision for the education of our masters is at present inadequate. The interesting question to be solved during the next few years is as to whether that which is required shall be supplied by the university colleges, to whose province it more strictly belongs, or by the technical schools which are now springing up all over the country. To the iron manufacturer the place at which his son is educated is a matter of indifference, so long as the proper education can be obtained. But the educationalist would prefer that the systematic course of instruction, commencing not earlier than in the student's sixteenth year, extending over three years, and requiring the whole of the student's time during that period, should, as far as possible, be conducted in connection with a university college, and should be certified to with the stamp of a university degree."

In the discussion following the paper the ideas coming from professors of metallurgy and lecturers coincided in the main with those of Mr. Turner. Prof. Arnold said that higher technical education would probably be opposed by vested interests, but would be supported by every technical instructor in the country. It appears that the lack of enterprise in the English ironmaster is the cause of his own threatened downfall.

The So-Called Selective Action of Cyanid.

THE problem of handling low-grade gold ores economically has been left to wet methods for solution almost entirely; metallurgical and mechanical processes are far too inefficient where large bodies of valueless gangue have to be handled, due largely to the cost of supplies incident upon the usual isolated location of the mines. Of all these wet processes, the only one which has attained any practical importance is the MacArthur-Forrest cyanid process, which is controlled by a company of speculators who have secured patents in most of the civilized countries, compelling the payment of royalties by all using the process. Owing to the extended application of cyaniding, these royalties became burdensome, and efforts are being made to prove the patents not valid. As an example of one of the arguments advanced against the company's claims, we abstract from an article in *The Australian Mining Standard* (Jan. 16), by Mr. James Mactear, which was read as a paper before the Institution of Mining and Metallurgy.

"It has been stated in one of the MacArthur-Forrest patents that 'in practice we find the best results are obtained with a very dilute solution, or a solution containing or yielding an extremely small quantity of cyanogen or a cyanid, such dilute solution having a selective action such as to dissolve the gold or silver in preference to the baser metals.' This, no doubt, seems to be a very definite assertion, but, when one begins to examine the actual facts, it is seen to be incorrect. As a matter of fact, no statement has ever yet been made —and supported by experiments—to prove that a strong solution 'attacks the baser metals without attacking the gold,' nor that the action of 'a weak solution is feeble and nil on the baser metals, but attacks the gold.'

"In discussing the question, it is necessary to bear in mind the fact that two types of action are involved. Firstly, the action of chemical affinity; and, secondly, the action of such chemical affinity assisted or modified by an electric current."

First, the author shows, from the experiments of Dr. Gore, the action of cyanid of potassium on "the above absolute proportionate weight of the various *metals* dissolved or 'corroded' from one square inch of surface in one hour. Taking the amount of gold dissolved as 100 parts, the following are the proportions for the metals named:—

Aluminum	1055	Gold	100
Zinc	600	Tin	66
Copper	588	Nickel	55
Silver	177	Iron	Trace

"It will be seen at a glance that gold is in the middle of the table, and that aluminum, zinc, copper, and silver are more readily soluble, or, in other words, the 'selective action,' so far as these metals are concerned, is in their favor, and against gold; while tin, nickel, iron, and platinum are less soluble, and as regards these metals the 'selective action' will be in favor of gold."

The *metallic oxids* were next experimented with, using three strengths of cyanid of potassium solution in the presence of metallic gold for a period of twenty-four hours. The results were as follows:

	I.	II.	III.
Cyanid of potassium in 1,000 parts of solution	5	20	50
Proportion of gold dissolved (No. 1 taken as 100)	100	237	550
Proportion of base metal oxids dissolved	100	100	100

"It will be observed that the proportion of base metal oxid remained constant for each of the three strengths of solution, the explanation of this fact being that the whole of the oxids were dissolved in each case, while the proportion of gold dissolved by the solutions increased with the strength of the solution, the whole of the gold, however, not being dissolved even in the case of the strongest solution.

"The *base metal compounds* most commonly met with in gold ores are the sulphids of iron, copper, lead, and zinc, in the form of iron and copper pyrites, galena, and zinc blende. In the case of these sulphids very considerable differences are met with in regard to the rate at which they are dissolved, their physical condition as well as their chemical composition affecting the action of the solution of cyanid of potassium upon them. Whatever the strength of the solution, its action is complicated by the presence of alkali as caustic or carbonate of potash, either present originally in the solution, or produced in it by the reactions taking place in the process. This alkali acts on the sulphid in certain cases, complicating the reactions, but experiment shows that, as a general rule, the amount of base metal dissolved is much greater than the gold or silver dissolved, even where oxygen is present. Thus, in the case of clean unoxidized iron pyrites containing gold equal to 11 dwt. 10 grains per ton, the finely-powdered ore was treated with half its weight of a solution containing 1.22 per cent. cyanid of potassium (equal to 0.49 per cent. cyanogen) for a period of 24 hours. The relative amounts of gold and base metal sulphids dissolved were—

	oz.	dwt.	gr.
Gold	0	8	14
Iron, as FeS_2	41	13	0

the percentage extraction of the gold being equal to 75.6 per cent., while 78.7 per cent. of the cyanogen had been used up."

Second: "So far we have been dealing with the question of solvent or chemical action only, but it is impossible to discuss the matter from this point of view alone, and it is necessary to consider the question of the 'selective action,' of dilute solutions upon ores as involving the effect of electric action also. If we now consider how this galvanic couple action affects the question of the so-called 'selective action,' there can be but little doubt that the solution of the gold is considerably accelerated by such an action. In the first instance, it may be well to place beyond doubt the fact that an electric current does very materially facilitate the solution of gold by cyanid of potassium."

Gold leaf was immersed in a dilute cyanid solution out of contact with either cathode or anode, and it was found that the same quantity was dissolved in 1½ minutes with the electric current acting as was dissolved in 10 minutes without the current. Experiments on ore gave varying results.

"There is, however, no doubt that, if the action of the cyanid solution be arrested immediately the gold has been dissolved, the dilute solution will be found to have dissolved—in the case of most ores containing sulphids—less of the baser metal compounds than will have been dissolved by the stronger solution. But this naturally follows, there being even in the most dilute solution employed an enormous excess of cyanid of potassium over the amount required for the solution of the gold, the excess cyanid, of course, exerting its solvent action upon the base-metal compounds. For example, the most dilute solution indicated in the MacArthur-Forrest patent is to contain 2 parts of cyanogen to 1,000 of water. If such a solution be used to treat an ore, such as Transvaal tailings containing 15 dwt. of gold per ton, there will be present about 160 times more cyanogen than is chemically required for the gold dissolved.

"Surely it is a mistake to call this a 'selective action' in favor of the gold. The answer to the statement, as given in the judgment of the court of appeal, with which we started, that 'a strong solution attacks the baser metals without attacking the gold, whereas a weak solution is feeble and nil on the baser metals, but attacks the gold,' is entirely contradicted by the results of both experimental and practical working of the process, which show in almost every case that the action of solutions of cyanid of potassium, whether strong or weak, is to dissolve a much larger actual weight of base metal compounds than of gold, while the electrochemical action set up by the formation of galvanic couples plays a most important part in the reactions that take place, the effect of which has not hitherto been sufficiently recognized."

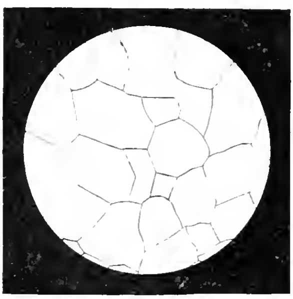


FIG. 1.—Primary crystals of pure copper. Slowly cooled. Magnified 11 diameters. Viewed with oblique light.

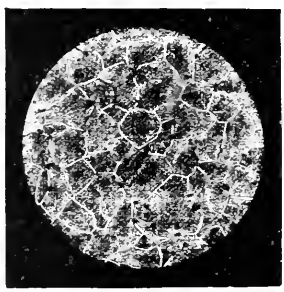


FIG. 2.—Copper containing 0.5 per cent. of bismuth. Slowly cooled. Magnified 11 diameters. Viewed with direct light.

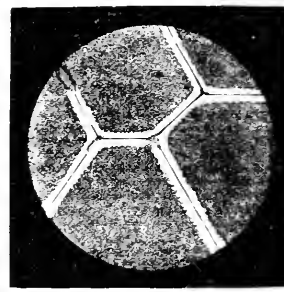


FIG. 3.—Copper containing 0.5 per cent. of bismuth. Slowly cooled. Magnified 66 diameters. Viewed with direct light.

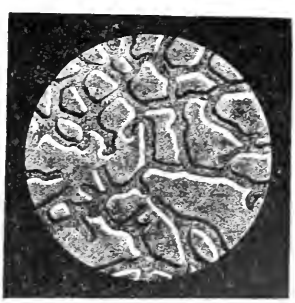


FIG. 4.—Copper containing 0.2 per cent. of antimony. Slowly cooled. Magnified 36 diameters. Viewed by oblique light.

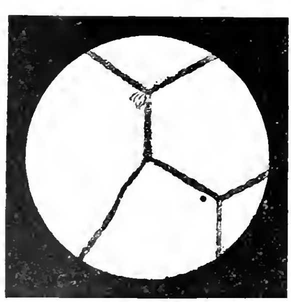


FIG. 5.—Copper containing 0.2 per cent. of sulphur. Slowly cooled. Magnified 66 diameters. Viewed with direct light.

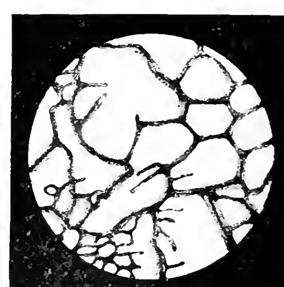


FIG. 6. Copper containing 0.2 per cent. of oxygen. Slowly cooled. Magnified 11 diameters. Viewed with oblique light.

Microscopic Tests with Copper Alloys.

THE scientific investigations of Professor Roberts-Austen in the field of metallic alloys have given to the world such an insight into the structural peculiarities of these interesting combinations as has never before existed. This line of work has been followed in the direction of microscopical examination of structure by Messrs. Arnold and Jefferson of the Sheffield Technical School, who report in *Engineering* (London, Feb. 7) the results of the tests of gold and copper alloys. The alloys prepared for the microscope by having "sections turned from the somewhat quickly cooled cast bars were 7.5 millimeters in diameter and 2.5 millimeters thick. They were polished, first, on fine emery cloth; second, on fine emery cloth (tightly stretched on a cast-iron block by means of a wedge ring) from which all loose emery had been removed by prolonged rubbing with a steel plate; third, on the finest kid skin tightly stretched on a cast-iron block and very lightly charged with the finest jeweller's rouge. The sections were etched in boiling aqua regia, washed, dried, and examined as opaque objects by means of the Sorby-Beck low-power reflectors and of the Beck high-power reflector." The alloying elements were incased between the rolls of copper, sulphur and oxygen being added in the form of Cu S and Cu O, and smelted in carbon crucibles protected from the air. Referring to the accompanying sections, the authors remark:

"*Pure Copper* (Fig. 1).—This drawing reproduces the primary crystals of pure copper magnified as before. Under high powers minute globules of the sulphid of copper were readily detected, although only 0.002 per cent. of sulphur was present. A shadowy granulation around the edges of the crystals also indicated the presence of traces of oxygen. In the copper alloys, unlike those of gold and excepting in the case of sulphur, the cell walls appeared in relief, being less soluble in the boiling dilute aqua regia used for etching than the copper itself.

"*Copper and Bismuth* (Fig. 2).—To obtain more conclusive evidence, an alloy containing 0.5 per cent. bismuth was made. The bismuth occurs not only as cell walls, but in isolated irregular globules. Prof. Goodman has shown that the addition of small percentages of metals of high atomic volume produces a remarkable increase in the friction of bearings. This fact appears to be explained by the behavior of the present alloys. It was observed during polishing that the isolated globules of bismuth, and indeed portions of the membranes themselves, fell out, the result being that the polishing track on the kid skin became coated with gray bismuth powder, and an increase in the friction was manually distinct. After etching, the section was slightly repolished, when the cavities formed by the falling out of the globules and membranes became filled with a mixture of rouge and bismuth powder, then presenting the appearance figured.

"*Copper and Bismuth* (Fig. 3).—It will be noticed that the sectional bismuth meshes each present a remarkably definite and straight plane of cleavage. Figs. 2 and 3 seem to offer a satisfactory explanation of the enormous falling off in the electrical conductivities of copper produced by the addition of small quantities of bismuth. A current, in the case of the pure metal, traverses a series of cohesive copper crystals; in the bismuth alloy it has, in its passage from one crystal of copper to the next, to pass through a wall of bismuth divided by a cleavage plane. A micrographic analysis of the metal bismuth itself reveals the presence of innumerable planes of cleavage resembling those of calcite,—a fact which probably accounts for its high electrical resistance.

"*Copper and Antimony* (Fig. 4).—This section shows that the latter metal produces very thick brown cell walls or sectional meshes, which seem in volume or area altogether out of proportion to the percentage of antimony present. However, on examination at high powers, the antimonid meshes are found to possess a distinct compound structure, consisting of alternate light and dark laminae, suggesting that in the first instance an attenuated antimonid involves the copper cells at a high temperature, but at a lower temperature the walls split up into plates of pure copper, alternating with those of a less basic antimonid. In this alloy the secondary crystals of copper contained within the antimonid membranes consist of remarkably perfect octahedra. This illustrates a fact noted throughout the present investigation—that thick cell walls usually inclose very geometrical secondary crystals, suggesting that the perfection of the latter is due to the protective action of the walls in relieving the cells themselves from contraction stresses.

"*Arsenic and Copper.*—The alloy containing about 0.2 per cent. arsenic presented a structure resembling that of the antimony alloy. The meshes, however, were green in color, and their compound structure was granular rather than laminated. Also the lines of division between the cells and walls were less acutely defined than those of the antimony alloy.

"*Copper and Sulphur* (Fig. 5).—The section of this alloy presented well-defined and geometrical primary crystals surrounded by somewhat attenuated sulphid walls. The sulphid also occurred in the form of green globules in the interior of the crystals, or sometimes near the edges in groups of elongated leaves. Sulphid which has escaped corrosion by the etching acid is green, but the cavities from which it has been dissolved out present a red-brown color. Often isolated globules or elongated patches of the green sulphid appear in the brown cavities between the copper crystals.

"*Copper and Oxygen* (Fig. 6).—This section is that of copper containing 0.2 per cent. of oxygen reduced from a drawing magnified 40 diameters. The cuprous oxid arranges itself in granular shadowy meshes, not only between the primary crystals, but also in the interior of the latter.

"*Zinc and Copper.*—Zinc appears to dissolve in copper, certainly in proportions up to 0.5 per cent., without producing any noticeable change in the micro-structure. Its behavior with copper appears to be identical with that of silver with gold.

"*Copper and Silicon.*—The structure of this metal presented a marked resemblance to that of the gold-silicon alloy, the sectional meshes of silicid being, however, in relief, granular in structure, and larger and less elongated than those of the gold alloy.

"It will be obvious that the facts recorded in the present paper open up a wide field of research, not only in metallurgy, but also in chemical physics."

High Explosives in Mines.

"AT a meeting of the North of England Institute of Mining and Mechanical Engineers held on Feb. 15," says *The Practical Engineer* (Feb. 21), "Mr. A. C. Kayll presented the report of the proceedings of the Flameless Explosives Committee." The explosions were made with bellite, securite, ammonite, roburite, carbonite, ardeer powder, and westfalit, in mixtures of coal-dust air and pit gas. The lengthy series of experiments, which has occupied the attention of the committee since March, 1892, appears to establish the following conclusions:

"1. The high explosives (ammonite, ardeer powder, bellite, carbonite, roburite, securite, and westfalit), on detonation, produce evident flame.

"2. The high explosives are liable to ignite either inflammable mixtures of air and fire damp, or air and coal dust, or air, fire damp, and coal dust, and therefore cannot be relied upon as ensuring absolute safety when used in places where such mixtures are present.

"3. The explosives are less liable than blasting powder to ignite inflammable mixtures of air and fire damp, air and coal dust, and air, fire damp, and coal dust.

"4. The experiments have shown that ignitions of mixtures of air and coal dust, with or without the presence of fire damp, can be obtained when there is present a much smaller quantity of coal dust than has been previously supposed to be necessary.

"5. It is essential that similar examinations of the working places and precautions which are in force in mines where blasting powder is used should be rigidly observed when a high explosive is employed.

"6. In selecting a high explosive for use in a mine, it should not be forgotten that the risk of explosion is only lessened, and not abolished, by its use.

"7. In view of the changes from time to time made in the proportions and constituents of high explosives, it is desirable that the name of the explosive should be printed on the wrapper of each cartridge, and that the date of manufacture and the proportion of the ingredients used in the manufacture of the explosive should be printed on the case of each packet of cartridges.

"8. As these explosives alter in character if improperly kept, it is necessary that every care should be taken in the storage to ensure their being maintained in good condition."

Sampling Ore.

THOUGH mechanical samplers have given satisfaction in large works, the usual methods of hand sampling possess so much flexibility as to be of universal application, and consequently are used everywhere with local modifications. The method employed in California is thus described by the *Mining and Scientific Press* (Feb. 22):

"When a quantity of ore is to be sampled, it is first broken by an ordinary rock-crusher into pieces the size of an English walnut, after which it is shoveled back into the car, but in such a manner that every fifth shovelful is thrown aside by itself, the remaining four-fifths being finally taken away. The fifth portion, known as the 'sample,' is then reduced to a much greater degree of fineness by means of Cornish rolls. It is then piled on the floor in a cone, flattened out and divided into four equal portions, and two opposite quarters are then removed. The remaining quarters are again thoroughly mixed and again piled in a cone, flattened and quartered, this operation being repeated until the sample is reduced to one hundred pounds. It is then weighed repeatedly for the purpose of determining the amount of moisture contained in the ore, which in some ores, especially those of the concentrates, is so considerable as to make a very appreciable difference in the weight. The moisture is then expelled, and the ore is crushed to such a degree of fineness that it can be passed through a sieve containing one hundred holes in the linear inch. The sample is next put up in small bottles, which are sealed with sealing wax and then stamped, for the purpose of preventing the possibility of their being opened or tampered with without detection."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Mining and Engineering Journals—See Introductory.

Metallurgy.

*4087. Practical Assaying at Mines and Works. H. Van F. Furman (Showing the methods of securing rapidity and accuracy in metallurgical works). Eng Mag–March. 3000 w.

*4100. Coal Dust Fuel (From the *Zeitschrift des Vereins Deutscher Ingenieure*, containing a tabulated statement of the heat distribution with the Wegener and the Schwartzkopff burners, with several kinds of powdered coal). Eng, Lond–Jan. 31. 1400 w.

*4116. The Effect of Silicon on Iron. M. Moissan (A paper communicated to the Académie des Sciences, Paris, giving the results of his experiments in making siliciurets in an electric furnace). Ir & St Trs Jour–Feb. 1. 600 w.

*4118. Copper. Nelson Dawson (Read at meeting of Arch. Assn. followed by discussion. History of the metal and its uses). Builder–Feb. 1. 9000 w.

*4123. Electrometallurgy in 1895. E. Andreoli (The encouraging progress in the applications of electrolysis to metallurgy). Elec Rev, Lond–Jan. 31. 3400 w.

*4124. The Aluminum Industry. G. L. Addenbrooke (The last year has proved a quiet but eventful one in this industry, and the work accomplished is reviewed). Elec Rev, Lond–Jan. 31. 2200 w.

*4145. Strength of Bronze in Compression. S. Bent Russell (These original tests are quite valuable. The results are shown in diagrams and tables, and fully discussed). Jour of Assn of Eng Soc–Dec. 1200 w.

4150. The Canadian Pig Iron Industry. George E. Drummond (An article of commercial interest, showing that Canada is using and producing more iron than is generally supposed. The producing localities are treated in detail). Can Eng–Feb. Serial. 1st part. 3300 w.

†4182. Iron Industry of Russia (Translated from the Vienna Hendels-Museum. The report shows that there is a large demand in Russia for pig iron and iron manufactures, and the industries are advancing so rapidly that foreign manufacturers will find a ready market for their products, though at small profits). Cons Reports–Feb. 2300 w.

4214. Milling in the Cooney Mining District, New Mexico. Carl Anderson (A tabulated statement itemized by months, and nine heads of expenses, etc., of results obtained by improved methods in silver milling. The author corrects a previous description by Mr. L. W. Tatum). Eng & Min Jour–Feb. 15. 500 w.

*4226. The Iron Industry of Austria-Hungary (From a British Foreign Office Report, describing the mines, charcoal furnaces, and iron works in Styria and Betler). Col Guard–Feb. 7. 1200 w.

*4230. Some Notes on Eastern Metallurgy (The methods of producing weapons of keen edge and ornamental appearance is referred to and briefly described). Ir & Coal Trs Rev–Feb. 7. 1800 w.

*4231. New Proposals for the Utilization of Blast-Furnace and Producer Gases (Description of a system now being tested for the utilization of a blast furnace as a gas producer, the production of iron being a secondary operation). Ir & Coal Trs Rev–Feb. 7. 1600 w.

*4235. Parkhead Forge, Rolling Mills and Steel Works. Ill. (Description of a notable English iron-works). Eng, Lond–Feb. 7. Serial. 1st part. 3500 w.

*4245. The Consett Steelworks (General description of a notable English works, illustrated by views). Ir & Coal Trs Rev–Jan. 31. 3300 w.

*4246. The Seraing Works of the Cockerill Company, Belgium (This company employ 10,000 men in its mines and works. The wages of the men are given, and the works described). Ir & Coal Trs Rev–Jan. 31. 2000 w.

*4247. The Micrographic Analysis of Metals. J. O. Arnold (The writer shows how the microscope may be utilized in the study of the fundamental structure of iron and steel). Ir & Coal Trs Rev–Jan. 31. 2200 w.

*4248. Recent Progress in Open-Hearth Steel Making. Bernard Dawson (The increasing demand for steel castings, improvements in charging and furnace construction, and the production and application of mild steel are treated in an interesting manner). Ir & Coal Tr Rev-Jan. 31. 2800 w.

*4249. Notes on the Electro-Crucible Fusion of Steel and Iron. B. H. Thwaite (The writer shows that in the electric furnace 16.05 % of the value of gas-engine fuel is utilized, while in ordinary furnaces but 3.09 % goes toward melting in the furnace). Ir & Coal Trs Rev-Jan. 31. 2500 w.

*4251. Economy of Electrical Power in the Iron and Steel Industries (A general article showing the growing application of electricity to machinery). Ir & Coal Trs Rev-Jan. 31. Serial. 1st part. 2000 w.

*4252. Foundry Practice at Home and Abroad (Recent developments and improvements). Ir & Coal Trs Rev-Jan. 31. Serial. 1st part. 1500 w.

*4253. Recovery of By-products and Utilization of Waste Gases in Coke Ovens (Practice in England and on the continent). Ir & Coal Trs Rev-Jan. 31. 2000 w.

*4254. Regulating the After-Blow in the Basis Process (The article recommends the reduction of time in the after-blow in the basic Bessemer converter, thus reducing the quantity of iron in the slag and increasing dephosphorization). Ir & Coal Trs Rev-Jan. 31. 800 w.

*4257. Some Recent Features of the American Iron Industry (With special reference to the enterprise of Americans and the magnitude of their undertakings). Ir & Coal Trs Rev-Jan. 31. Serial. 1st part. 1700 w.

4258. Loss in the Thomas Process. Abstract from *Stahl und Eisen* (The article gives the total loss ranges between 13 % and 17 %, itemized). Am Mfr & Ir Wld-Feb. 14. 700 w.

†4276. Methods for the Collection of Metallurgic Dust and Fume. Malvern W. Iles (A valuable synopsis with a brief description of each of the eight processes which have been used for the purpose). Sch of Mines Quar-Jan. 10500 w.

†4278. Notes on the Assay of Rich Silver Ores. Edmund H. Miller and Charles H. Fulton (The object of this work is to locate the loss of silver in the different operations, essential to the assay of a rich silver ore, by determining the amounts which can be recovered from the slags and cupels. Also to determine the best method of assaying two particular ores). Sch of Mines Quar-Jan. 2700 w.

†4279. An Explosion in a Zinc-Fume Condenser. Charles F. McKenna (The explosion which wrecked one end of the condenser was attributed to spontaneous combustion of pyrophoric zinc fumes). Sch of Mines Quar-Jan. 1500 w.

*4291. Influence of Small Quantities of Impurities on Gold and Copper. J. O. Arnold and J. Jefferson (The experiments showed that metals with relatively high atomic volumes when alloyed with gold, made the alloy fragile, while those of about the same atomic volume produced little effect. The article is illustrated by twelve microscopic sections of alloys of gold and copper with bismuth, silver, aluminum, silicon, antimony, sulphur and oxygen). Engng-Feb. 7. 3600 w.

†4328. Assays of Copper and Copper Matte (Discussion of the results presented at the Florida meeting, 1895). Trans Am Inst of Min Engs-Feb. 3300 w.

†4329. The Accumulation of Amalgam on Copper Plates. R. T. Bayliss (The author shows that the gold fineness of the amalgam on the plates is highest near the battery, while the corresponding silver fineness is highest further away). Trans Am Inst of Min Engs-Feb. 2200 w.

†4330. The Effect of Vibration upon the Structure of Wrought Iron (Continued discussion). Trans Am Inst of Min Engs-Feb. 1700 w.

†4331. Note on Carbon-Bricks in the Blast Furnace. R. W. Raymond (The bricks have proven quite satisfactory but have not been used long enough to determine the life). Trans Am Inst of Min Engs-Feb 600 w.

†4332. The Effect of Washing with Water upon the Silver Chloride on Roasted Ore (Discussion of the paper of Mr. Willard S. Morse, by L. D. Godshall). Trans Am Inst of Min Engs-Feb. 2800 w.

†4333. Notes on the Handling of Slags and Mattes at Smelting-Works in the Western United States. William Braden (Designs of settling pots and fore-hearths are given and the practice in the principal works described). Trans Am Inst of Min Engs-Feb. 3700 w.

†4334 Gold-Milling in the Black Hills, South Dakota, and at Grass Valley, California. T. A. Rickard (Comments suggested by visits to the stamp mills of both localities with valuable tables of cost, consumption of mercury, labor employed and illustrated descriptions of the later installations). Trans Am Inst of Min Engs-Feb. 9000 w.

4353. Rolling-Mill Feed Table. Ill. (The device consists of endless chains with roller link joints, which are cooled by passing through water under the feed table). Ir Tr Rev-Feb. 13. 600 w.

4354. Dynamite in Blast Furnace Practice. John S. Kennedy (The method, with precautions, is described and the method of applying cartridge is illustrated). Ir Tr Rev-Feb. 13 900 w.

4355. Coke for the Foundry. Thomas D. West (Its characteristics, methods of manufacture and a founder's experience with it. Illustrated by sections of coke ovens). Ir Tr Rev-Feb. 13 Serial. 1st part. 1400 w.

4364. Coking in Upper Silesia. M. Gouvy (A paper communicated to the Soc. of Mineral Industry, St. Etienne, France, giving general description of the several plants, with statistics). Am Mfr & Ir Wld-Feb. 21. 1500 w.

*4365. Aluminum Bronze (Abstract from the *Aluminum World*. The properties are described). Aust Min Stand-Jan. 16. 700 w.

4367. The Aluminum Industry. Orrin E. Dunlap (Electric smelting at Niagara Falls is described, and the yearly production since 1883 is tabulated). Min & Sci Pr-Feb. 15. 1400 w.

*4389. Technical Instruction in Its Application to Ironmaking Thomas Turner (The paper is given in full, with discussion. Read before the South Staffordshire Inst. of Iron and Steel Works' Managers). Ir & St Trs Jour-Feb. 15. 5300 w.

*4421. The Manufacture of Aluminum by Electrolysis, and the Plant at Niagara for its Extraction. Alfred E. Hunt (Read before the Inst. of Civ. Engs. The description is condensed and gives many details of the process). Col Guard-Feb. 14. 1300 w.

*4422. The Chemistry of the Siemens Furnace. A. M. Dick and C. S. Padley (Paper read before the West of Scotland Iron and Steel Inst. A comprehensive, elementary explanation). Col Guard-Feb. 14 1700 w.

4446. Galvanizing. W. T. Flanders (The process is described in detail). Ir Age-Feb. 27. 3000 w.

4447. Bessemer on Nickel Steel (Interesting notes from Sir Henry Bessemer's note book which are made as far back as 1842). Ir Age-Feb. 27. 1700 w.

4448. The Morgan-Allen Continuous Heating Furnaces (Description illustrated by drawings in plan and section. Each charge of these billets pushes the others toward the drawing door). Ir Age-Feb. 27. 600 w.

4460. Modification of the Chlorination Process (The process consists in the addition of caustic soda and slaked lime to the ores, to prevent the deterioration of the salt employed. The rationale is fully treated). Min & Sci Pr-Feb. 22. 1400 w.

4464. A Furnace Plant in Alabama. "Englasia" (Well illustrated description of furnace, coking ovens, hoists and cars). Foundry-Feb. 900 w.

4475. The Mobility of Molecules of Cast Iron. Alex. E. Outerbridge, Jr. (A paper read at the Pittsburg meeting of the Amer. Inst. of Min. Engs. As the result of experiments the surprising statement is made that "cast iron is materially strengthened by subjection to shocks or repeated blows"). Eng News-Feb. 27. 3000 w.

*4516. The Treatment of Antimony Ores (Discussion of the New Halloway-Longridge process for extracting gold from antimony ores. It is interesting because little is known of the metallurgy of antimony). Min Jour-Feb. 22. 1800 w.

4519. Selling of Pig Iron on Analysis. C. R. Baird & Co. (Response to a letter from William R. Webster, asking C. R. Baird & Co. to give the results of their experience in selling pig iron on analysis. Presented at the Pittsburg meeting of the American Inst. of Min. Engs., as part of the discussion on "The Physics of Cast Iron"). Ir Tr Rev-Feb. 27. 900 w.

4520. The Latest in "Baby Bessemer" Practice. H. L. Hollis (Synopsis of a paper entitled "Notes on the Walrand-Legenisel Process for Steel Castings" read at the Pittsburg meeting of the Amer. Inst. of Min. Engs). Ir Tr Rev-Feb. 27. 1200 w.

4521. Expansion and Shrinkage of Cast Iron. William R. Webster (Contributed to the discussion on "The Physics of Cast Iron" at the Pittsburg meeting of the Amer. Inst of Min. Engs. The results of tests made in 1889 are plotted in curves, and the manner of making the tests is illustrated and described). Ir Tr Rev-Feb. 27. 500 w.

*4565. The Iron and Steel Industries of South Russia (The first of a series of short illustrated articles. It describes the Krivoi Rog Iron Works, which have a production of 50,000 tons of pig iron per year). Ir & St Trs Jour-Feb. 22. Serial. 1st part. 1100 w.

4601. The Walrand-Legenisel Process. H. L. Hollis (Read at the Pittsburg meeting of the Am. Inst. of Min. Engs. This consists essentially in adding ferrosilicon at the time the flame drops in a Bessemer converter and making an after-blow, with the idea of preventing blowholes in castings). Ir Age-March 5. 1500 w.

*4612. How Germany Cancelled the Cyanide Patent. G. G. Turri (A translation of the decision of the Imperial German Court by which the cyanide patent was cancelled. The argument is given in full). Aust Min Stand-Jan. 30. 2400 w.

†4616. The History of Electric Heating Applied to Metallurgy. Frederic P. Dewey (Read before the Washington Section. A description of the several forms of apparatus which have been designed and used up to the present time. Illustrated by 13 cuts). Jour Am Chem Soc-March. 7000 w.

4654. The Comparative Efficiency of West Virginia Coals. James W. Paul (The composition of 17 varieties of coal with their thermal efficiency and other characteristics are given). Eng & Min Jour-March 7. 800 w.

*4696. The Practical Determination of the Binding Power of Coal. Louis Campredon (Paper read at the Académie des Sciences de Paris. The author shows by examples that the composition of coals does not indicate their coking properties). Ind & Ir-Feb. 28. 800 w.

*4697. The Direct Puddling of Iron. Emile Bonehill (The author's reply to the discussion of his paper on Direct Puddling, read at the Iron & Steel Inst. meeting. It contains much detailed information). Ir & St Trs Jour-Feb. 29. 2200 w.

†4699. Smokeless Firing and Powdered Coal for Steam Boilers (Description of the Wegener apparatus). Ind & East Eng-Feb. 8. 600 w.

Mining.

*4085. Prospecting with the Diamond Drill. Ill. J. Parke Channing (Showing the methods employed in the different classes of diamond drilling, the difficulties encountered, and the devices resorted to in case of mishap). Eng Mag-March. 4500 w.

*4096. New Belgian Regulations as to the Use of Explosives in Collieries (From a Belgian Royal decree, dated 13th Dec., 1895: The rules are intended to lessen accidents due to explosives). Col Guard-Jan. 31. 1800 w.

*4097. Working Mines by Mortgagees in

Possession (Cases in equity defining the privileges of the party holding mortgage). Col Guard–Jan. 31. 1800 w.

*4098. The Air of Coal Mines. Frank Clowes (A lecture delivered at the University College, Nottingham, showing that the flame test was not reliable in the presence of carbonic oxide, but that mice are twenty times more sensitive to it than a man, and that blackened coagulated blood will turn pinkish in the presence of carbonic oxide; therefore, these tests might be of practical utility). Col Guard–Jan. 31. 700 w.

†4180. American Coal for Belgium (A translation from *The Industrial Review*, of Charleroi, is quoted which shows, by calculations, that the shipping of coal from America to Europe can be accomplished at a profit. The consul agrees, suggesting Ghent as the best port for cotton vessels, with coal ballast). Con Rept–Jan. 1600 w.

4188. The Butterfield Tunnel Scheme (A remarkable tunnel reaching a depth below the surface of 2200 ft. and having a length of 8200 ft. It will tap and drain the two mines owned by the company). Min & Sci Pr–Feb. 8. 1600 w.

4189. The Woods' Dry Placer Miner (The device consists of a disintegrator, resembling an inclosed ore washer, which delivers its pulverized product to an inclined table having riffles at intervals and having a bottom of coarse cloth through which a bellows underneath drives the air in pulsations as in jigging. The gold settles to the surface of the cloth and is there collected). Min & Sci Pr–Feb. 8. 650 w.

*4202. Metal Mining.—Ventilation by Natural Draft and by Assisted Draft. Albert Williams, Jr. (Importance of ventilation in metal mines is less than in collieries, but too often overlooked. The sources of vitiation of mine air, special need of studying and utilizing natural draft, working rules and practical suggestions for controlling air currents underground are discussed). Col Eng–Feb. Serial. 1st part. 5500 w.

*4203. Wire Rope Haulage. T. E. Hughes (Read before the Ohio Inst. of Min. Engs. The writer shows the necessity of proper study of conditions in deciding on type, and that the avoidance of friction is necessary to secure most satisfactory and economical results). Col Eng–Feb. 2500 w.

*4204. Explosives for Coal Mines.—Their Classification, Composition and Gaseous Products of Combustion. Vivian B. Lewes (From Trans. of the Fed. Inst. of Min. Engs. A comprehensive study or the safest explosives for use in gaseous and dusty mines). ColEng-Feb 4500 w.

*4205. Prospecting for Gold—Gold Placers; How They are Worked. Arthur Lakes (Theories of the origin of gold sands and the history and distribution of gold placer deposits throughout the world. Illustrated by maps showing locations of gold deposits in Europe, Asia and Africa). Col Eng–Feb. Serial. 1st part. 2500 w.

*4206. Iron Ore Mining. Charles Dean Wilkinson (From the Year Book of the Soc. of Engs., Univ. of Minnesota. Systems of mining used in Minnesota iron mines). Col Eng–Feb. 1600 w.

4215. Ancient Coal Mining. Walter H. Mungall (Paper read before the British Soc. of Min. Students on some interesting facts from the historical records of Scotch coal mining). Eng & Min Jour–Feb. 15. 1500 w.

*4225. The Loire, Gard, and Creusot-Blanzy Coalfields of France (From the *Atlas* of the Comité Central des Houillères de France. General description of coal fields, composition of coals and economic conditions). Col Guard–Feb. 27. 2600 w.

*4227. Percussion Fuses and Their Suitability for Fiery Mines. J. van Lauer, *Oesterreichische Zeitschrift für Bergund Huttenwesen*. A comparison of advantages of various fuses is made, and the advantages of the friction fuse discussed). Col Guard–Feb. 7. 1100 w.

*4229. Simultaneous Sinking and Tubbing of a New French Pit. Léon Thiriart (Translated from *La Revue Universelle des Mines, de la Metallurgie, etc.* A very complete description with construction details fully illustrated). Col Guard–Feb. 7. 3600 w.

*4242. Sampling and Measurement of Ore Bodies in Mine Examinations. Edmund B. Kirby (A thoroughly practical article). Aust Min Stand-Dec. 28. Serial. 1st part. 3300 w.

*4250. The Use of Electricity in Mining Operations (The method of firing shots by means of an electric fuse is described and the method of making connections illustrated). Ir & Coal Trs Rev–Jan. 31. Serial. 1st part. 1400 w.

4275. Placer Deposits in New Mexico. Cecil A. Deane (The article describes the way in which the gold occurs in the several districts). Min Ind & Rev–Feb. 13. 2700 w.

4319. The Gold Fields of the Transvaal (This article is written in popular style and gives an interesting picture of native miners going to work, a zebra propelled stage coach, and a gold productive diagram from 1887 to 1895). Sci Am Sup–Feb. 22. 1400 w.

†4322. Notes on the Kaolin- and Clay-Deposits of North Carolina. J. A. Holmes (The paper treats of both the Kaolin deposits "in place" and the sedimentary clays, describing their method of occurrence and uses to which they are put). Trans Am Inst of Min Engs–Feb. 2000 w.

†4323. The Ore-Deposits of the Australian Broken Hill Consols Mine, Broken Hill, New South Wales. George Smith (The lode has a thickness of 18 inches with well defined walls and has been worked 1300 ft. A section of the deposits is given in connection with the description). Trans Am Inst Min Engs–Feb. 3400 w.

†4324. The Cycle of the Plunger-Jig. Robert H. Richards (A series of 41 curve diagrams representing the pulsations in the Harz, Crank, and Collom jigs, and the deductions that can be drawn from them. Interesting data are given as to the jig practice in a number of our prin-

cipal ore dressing works). Trans Am Inst of Min Engs–Feb. 2800 w.

†4325. The Theory and Practice of Ore-Sampling. D. W. Brunton (The subject is discussed from both a practical and theoretical standpoint. Tabular statements and diagrams are presented and formulæ derived). Trans Am Inst of Min Engs–Feb. 4000 w.

†4326. Mining Titles on Spanish Grants in the United States. R. W. Raymond (Considerations affecting the validity of a mining deed). Trans Am Inst of Min Engs–Feb. 3000 w.

†4327. Present Condition of Gold-Mining in the Southern Appalachian States (Discussion of the paper of Messrs. Nitze and Wilkens, containing additions and corrections). Trans Am Inst of Min Engs–Feb. 4800 w.

*4362. Notes on the Ore Deposits of the Malaga Serpentines (Spain). Fritz Gillman (Paper read before the Inst. of Mining and Metallurgy. A mineralogical description of the nickel and iron ore deposits). Min Jour–Feb. 15. 2500 w.

*4363. Cripple Creek Goldfield (Colorado). T. A. Rickard (General Description by the Colorado State Geologist). Aust Min Stand–Jan. 4. 1500 w.

4366. Transporting Mining Machinery. Ill. (Transporting an 800-lb. cam shaft through a timbered country to an Oregon gold mine). Min & Sci Pr–Feb. 15. 600 w.

4396. Manufacture, Use and Abuse of Dynamite. Harry A. Lee (A paper by the California State Commissioner of Mines, on the precautions necessary in handling and using dynamite). Eng & Min Jour–Feb. 22. 1600 w.

4417. The Burns Gold Mine, North Carolina. H. M. Chance (A brief description). Eng & Min Jour–Feb. 8. 800 w.

*4418. A Large Coal-Screening and Washing Plant (Description illustrated by plans and sections of plant). Col Guard–Feb. 14. 1400 w.

*4419. Colliery Explosions and Coal Dust. James Ashworth (Examination into the occluded combustible gases, the ignition point of coal dust, and the after damp in British mines). Col Guard–Feb. 14. 2600 w.

*4420. Apparatus for Experimenting with Firedamp. H. Schmerber, in *Le Génie Civil* (The apparatus is illustrated by detail drawings, and is intended to show the effect of various gases on the lamp flame). Col Guard–Feb. 14. 1500 w.

4437. Lighting Hydraulic Mines. Ill. W. W. Briggs (The use of incandescent lamps at night is described and their economy shown over bon-fire illumination as being in the ratio of $3.18 to $11.50 per 12 hour shift). Jour of Elec–Jan. 600 w.

4458. An Interesting Example of Ropeway Practice (This ropeway conveyor handles 200 tons daily, at about 2½ cts. per ton, using 8 h. p., conveying the tailings about a mile. The special features are a 60° turn mechanism, and an automatic loader, both illustrated). Min & Sci Pr–Feb. 22. 900 w.

4459. Testing the Ores (The method usually employed of sampling the ores at the mines is briefly described). Min & Sci Pr–Feb. 22. 450 w.

*4469. The Mining Industry of the Dutch East Indies (A cursory view of the petroleum and gold industries). Bd of Tr Jour–Feb. 800 w.

*4514. Expedition in Search of Coal in the Districts Immediately South of the Zambesi. Charles J. Alford (An interesting account of the expedition giving the principal features and resources of the region). Min Jour–Feb. 22. Serial. 1st part. 3300 w.

*4515 Gold Mining in the Hauraki District, New Zealand. Henry M. Cadell (Abstract of a paper recently read before the Mining Inst. of Scotland. The counties and districts are noticed separately and much valuable information given concerning them). Min Jour–Feb. 22. Serial. 1st part. 2400 w.

*4517. The Future of the South African Mining Industry (The editor thinks that though affairs have a gloomy aspect now, the prospects for the future are quite reassuring though not very bright). Min Jour–Feb. 22. 1800 w.

4550. The Lake Harold Gold Mine (A brief illustrated description of a rich Ontario mine). Can Min Rev–Feb. 2200 w.

4551. Gold in British Columbia. R. C. Campbell-Johnstone (A brief review of the field). Can Min Rev–Feb. 3200 w.

*4559. The Use of Congelation in Mining Operations (From a communication by M. F. Schmidt, to the Société de l'Industrie Minérale, Saint Etienne. A condensation from the original exhaustive article which covers the entire field and deals with both the scientific and economic applications of this principle. Col Guard–Feb. 21. Serial. 1st part. 3700 w.

*4566. High Explosives in Mines (The report of the "Flameless Explosives" Committee to the N. of Eng. Inst. of Min. & Mech. Engs. The article gives the conclusions arrived at after exhaustive experiments). Prac Eng–Feb. 21. 900 w.

4567. Cyanide Process of Treating Gold Ores (The reason why cyaniding cannot be applied to Southern gold ores is because much of the gold is associated with iron pyrites which is dissolved by the cyanide to such an extent as to foul the solution). Tradesman–March 1. 1300 w.

*4613. A Study of Some Ore Deposits. F. D. Johnson (The first paper read at the inaugural meeting of the A. I. M. E. Discussion of the "indicator" and lode systems of deposits in Australia). Aust Min Stand–Jan. 30. 2800 w.

*4614. Concentration of Auriferous Sulphides in California (The milling plant of the Golden Gate gold mine at Sonora is considered a model of its kind, and a brief description is given). Aust Min Stand–Jan. 30. 800 w.

*4615. Methods of Mine Timbering (A detailed description of devices for various uses with cuts of a Black Hills gold mine). Aust Min Stand-Jan. 23. 2600 w.

4634. The Corral Hollow Coal Mines (Well illustrated description). Min & Sci Pr–Feb. 29. 200 w.

4635. Comstock Ore Sampling. John D. McGillivray (An enumeration of defects in practical sampling and an exposition of the unsatisfactory method employed on the Comstock lode). Min & Sci Pr–Feb. 29. 3200 w.

4636. Some Notes on "Crossings." Herbert C. Hoover (The crossing referred to is where the vein passes through some material differing from the country rock. Sections illustrating crossings through slate are given and the statement made that the vein continues usually on the other side). Min & Sci Pr–Feb. 29. 1200 w.

4637. North Carolina Gold Fields. J. J. Newman (The communication discusses the need of a central reduction plant and gives a map showing location of gold mines in ten counties, with tabular statement showing character and production). Mfrs Rec–March 6. 1200 w.

4655. The Hydraulic Gravel Elevator at the Chestatee Mine, Georgia. W. R. Crandall (Abstract of a paper presented at the Pittsburg meeting of the Am. Inst. of Min. Engs. The description of the apparatus is condensed and lucid and is illustrated by a section of nozzle and a cut of the general arrangement). Eng News–March 5. 600 w.

*4695. A New Spanish Coal Basin. Francis Laur (Translated from *L'Echo des Mines et de la Métallurgie.* Interesting particulars regarding a new coal basin in Old Castille, in the north of Spain). Col Guard–Feb. 28. Serial. 1st part. 2800 w.

†4698. The Design and Testing of Centrifugal Fans. H. Heenan, and W. Gilbert (Abstract of a paper read at the meeting of the Inst. of Civ. Engs. The results of tests made to determine the discharge and efficiency of fans, and their effect on the design of fan-blades and fan case). Ind & East Eng–Feb. 8. 900 w.

*4700. Victorian Gold Mining. Thomas Cornish (Misleading statements in prospectuses). Min Jour–Feb. 29. 1500 w.

*4711. The Transvaal: Its Mineral Resources. J. Logan Lopley (An excellent description, including statistics from the State Mining Engineer's report, and geological section of the deposits, and a map of the State). Knowledge–March 2. 3300 w.

Miscellany.

*4112. The Royal School of Mines (A series of toasts relating to mining delivered at the annual meeting of the alumni. The speeches are necessarily general and quite readable). Min Jour–Feb. 1. 10500 w.

*4113. The Useful Minerals of Tasmania. A. Montgomery (Paper read before the I. M. E., Hobart meeting. The minerals are mentioned as they occur in the several geological formations). Min Jour–Feb. 1. Serial. 1st part. 3000 w.

*4241. The Manufacture of Sulphuric Acid from Auriferous Pyrites. Walter J. Studds (A suggestion for working up concentrated tailings). Aust Min Stand–Dec. 28. 1500 w.

*4255. The Coal Ports of the United Kingdom. Cardiff. Ill. (The shipments from this South Wales port increased in the past 56 years from 4000 to 12,000,000 tons annually. The necessary improvements consequent are described in the article). Ir & Coal Trs Rev–Jan. 31. Serial. 1st part. 4900 w.

†4335. Corundum of the Appalachian Crystalline Belt. J. Volney Lewis (Principally the result of work of the N. C. Geol Surv. The paper treats of the geology, associated rocks, mineralogical occurrence, mining methods and literature of corundum). Trans Am Inst of Min Engs–Feb. 20000 w.

†4336 Recent Phosphorus Determinations in Steel (Discussion of the paper of Mr. Thackray. Comparison of results from six methods. Mr. Blair thinks that check assays by different methods are better than duplicate assays by the same method). Trans Am Inst of Min Engs–Feb. 1000 w.

†4337. The Assay of Silver-Sulphides (Discussion of the paper of Mr. Furman bringing out the fact that iron nails are not only unnecessary but may occasion loss in assays of rich sulphide). Trans Am Inst of Min Engs–Feb. 700 w.

†4338. The Monazite Districts of North and South Carolina. C. A. Mezger (A general description of deposits and method of working). Trans Am Inst of Min Engs–Feb. 2500 w.

†4339. The Phosphates and Marls of Alabama. Eugene A. Smith (Geological relations with description of deposits). Trans Am Inst of Min Engs–Feb. 4300 w.

†4340. Notes and Recollections Concerning the Mineral Resources of Northern Georgia and Western North Carolina. William P. Blake (Gold, silver, copper, zinc, iron, coal, building stone and other mineral occurrences are described). Trans Am Inst of Min Engs–Feb. 5400 w.

†4341. Folds and Faults in Pennsylvania Anthracite Beds (Postscript). Trans Am Inst of Min Engs–Feb. 400 w.

†4568. The Mineral Deposits of Eastern California. Harold W. Fairbanks (The economic geology of the gold and the silver and lead deposits with discussion and conclusions). Am Geol–March. 5600 w.

4602. Notes on Conveying Belts and Their Use. Thomas Robins, Jr. (Read at the Pittsburg meeting of the Amer. Inst. of Min. Engs. An excellent paper giving the best practice and also illustrations of conveyor pulleys and feeding arrangements). Ir Age–March 5. 2800 w.

†4607. On Trinidad Pitch. S. F. Peckham and Laura A. Linton (An excellent description of the Trinidad pitch lakes with map and a full discussion of the analysis of the asphalt and tabulated analyses). Am Jour of Sci–March. 5000 w.

*4694. Welded Steel Mains and Joints. J. G. Stewart. (Paper read before the Manchester Assn. of Engs. The advantages of steel and of cast iron pipes are discussed, especially when transportation is a factor. The article is illustrated by 9 views and sections of joints used in steel pipes). Ind & Ir–Feb. 28. 3500 w.

MUNICIPAL ENGINEERING

Clarification of Sewage at Richmond, England.

THE process of clarification at Richmond (on the Thames river), Eng., seems to be a very effective one. It is described in the following abstract of an article in *Machinery* (London, Feb. 15).

Worthington pumping engines capable of dealing with five million gallons of sewage daily, when this capacity is required, are employed for moving the sewage through the various stages. Before the sewage reaches the pump chamber, it has to pass through a strainer of iron rods, which prevents the passage of bulky matter in the refuse. Then it flows in a continuous stream into the pump chamber, and there is charged with milk of lime from the chemical vats. The process of pumping thoroughly blends the sewage and the lime. The mixture then flows from the delivery pipes of the pumps into a channel for the treated sewage, where another iron bar strainer intercepts any heavy matter that may have escaped the first. Then it is again charged with sulphate of alumina and carbon, and is carried to the tanks by a fresh channel, which communicates with the first by means of valves that can be opened according to requirement. The sewage rises to the level of a weir forming the outer side of the channel, and overflows it until the tank is filled or the valve closed. By the time the tanks are filled the bulk of the solid matter has been precipitated, and the effluent water flows away over weirs at the other end of the tanks. At this stage of the process the water has been sufficiently clarified to be discharged into the river, to which an outlet is provided opening into its bed in mid-stream at its greatest depth. But, in order to obtain a higher purity, it goes through a course of filtration through filter beds composed of a surface of agricultural soil, on which grass is grown, with layers of gravel, sand, and carbon. The effluent water passes gradually through these filter beds, and reaches the river outlet with a degree of purity which, while it would not justify its use for domestic purposes alone, yet, when mixed with the river water, is perfectly drinkable. It is as clear as crystal, and runs over the weir with the limpidity of a trout stream in dry weather. A few hours before, it was pouring into the pump room, a volume of black sludge, almost appalling to the sight. It may happen in times of high spring tide, when the river is filled with land water, that the discharge from the filter beds cannot take place by gravity. When that is the case, steam pumps are set to work to pump the effluent water out.

The solid matter, if it can be called solid, which is precipitated to the bottom of the tanks, is from two to three inches in depth, and a certain depth of water is allowed to remain above the sludge to the extent of six or seven inches. As the bottoms of the tanks have a slope of one in sixty, the precipitate, with the overlying water, passes gradually into a fresh chamber, where another process of precipitation takes place, and the water which remains at the top of the sludge is drawn off, repasses into the pump chamber, is mixed with the sewage again, and treated as fresh sewage. Then the sludge, having lost much of its moisture, is lifted into iron receivers by pumps, where lime is added to it again to make it more amenable to pressure, and rams are employed to press the water out of it and force the solid matter into the presses. The water goes back again into the pump chamber, and the sludge is pressed into solid cakes, measuring 3 ft. square by 1½ in. thickness, and taken from the presses.

By this time it is as free from noxious smell as the effluent water is from impurity. It can be stored in heaps in the open air without creating nuisance, and it possesses a certain value for manurial purposes. In the main drainage works, the sludge, once pressed, is placed on trucks and carted down to the quay, where it is run on board a barge and carried away as a marketable article. But the sludge, it must be distinctly understood, represents no return to the board of sewerage or the ratepayers. The contractor has to be paid for taking it away. He disposes of it down the river, in Essex or Kent, for the best price he can get; and there are lands to which it is specially suited, whose owners or occupiers are glad to have it. It may be added that the sludge, when not pressed out to the fullest possible extent, is yet found a very valuable material for raising low-lying lands, filling up ditches and ponds, and otherwise levelling fields.

Supply of Sea-Water to London.

FOR a long time the use of sea-water in cities for watering streets and for fire extinguishing has been recognized as an available future resource when the supply from other sources ceases to be sufficient both for these purposes and for potable and domestic use. It is probable that some American seaboard cities would already have used sea-water in this way, had there not been up to the present time sufficient water attainable from other sources at less cost. But little thought is required to convince any one that the expense of such a system for a city like New York would be enormous both in first cost and in subsequent operation, as a separate system of distributing mains and large pumping engines would be needed. The effect upon the public health of cities of the use of sea-water for street-watering has been experimentally determined, so that in any case we may predict in advance that the use of pure sea-water will be salutary. It is true that streets and pavements become more or less saturated with the crude salts dissolved in the water, but the effect of this addition to the complexity of street-dust when inhaled constantly has not been found detrimental. The chilliness of pavements in winter during snowfall is undoubtedly increased, and this is about the only objectionable concomitant. However, the experiment is to be tried in London on a much larger scale than has hitherto been attempted. The details of this scheme are given in a paper read by Mr. Frank Grierson before the Society of Arts, reprinted in *The Architect and Contract Reporter* from the *Journal* of that society.

Nine or ten millions gallons are to be supplied daily. The intake is to be opposite Lancing, between Brighton and Worthing, the sea-water having great purity at that point.

The sea-water will first be pumped into a reservoir or settling-tank at Lancing, the bottom of which is about ten feet below high water; this reservoir will have a capacity of ten million gallons. The water is thence forced to a reservoir situated near the summit of Steyning Round Hill. The pumps and machinery are all situated alongside the reservoir at Lancing. This is, therefore, the only pumping station in the whole system. It adjoins the railway, and is provided with its own sidings for coal, &c. The Steyning reservoir will be situated nearly five hundred feet above high-water level, and will have a capacity of ten million gallons. The sea-water will flow thence, by gravitation, to a third reservoir at Epsom, over two hundred feet above high-water level; this also will have a capacity of ten million gallons. From this reservoir the sea-water will flow, by gravitation, to London, where it can be delivered under the pressure due to this head which is greater than that which most of the water companies command. The sea-water will be conveyed in mains the whole distance, and, as there will be two days' supply in the Steyning and Epsom reservoirs together, the mains will be always full. It is a practical impossibility that they should ever be frozen.

The first place to make habitual use of sea-water was Ryde, England, more than forty years ago. Tynemouth was the next, in 1872. Barrow-in Furness, Birkenhead, Blackpool, Bootle, Bournemouth, Falmouth, Great Yarmouth, Grimsby, Gosport, Harwich, Littlehampton, Plymouth, Portsmouth, Shoreham, South Shields, Torquay, Weymouth, and other places have since followed those examples. It is found that once watering with sea-water is equal in efficiency to twice or even thrice watering with fresh water. Sea-water keeps the road-surface moist for a long time, but without slush. It hardens and binds macadam roads, and forms a preservative crust which prevents dust from rising. It is the one thing needed to make wood-paving perfect, as, by retarding the decomposition of the street-refuse, it will effectually prevent the annoyance of any smell arising therefrom, of which annoyance public complaint has occasionally been made; when wood-paving has displaced granite and macadam, this is a feature worth mentioning. The proportion of salts in sea-water is about 3½ per cent., or, more exactly, 36½ parts per 1,000. Of these, nearly 30 parts are chlorid of sodium, or common salt, and about 3½ parts are chlorid of magnesium; it is owing chiefly to the deliquescence of these salts that the roads remain sufficiently moist for so long. A ton of sea-water contains about 220 gallons, from which are deposited 80 pounds of salts. A water-cart will spread a ton of water over a surface of from 1,900 to 2,000 square yards.

The cost of sea-water for street-watering in London probably will be less than that of fresh water; but, were it even the same, it is claimed, the advantage and economy of sea-water would be great, because the quantity used would not exceed half the present quantity used; the cost of distribution, horse-wear, etc., would be correspondingly reduced, and the roads would last longer in sound condition, and cost less to repair. This is the recorded experience of the places which have used sea-water. In the hottest weather, when water is most required, there is now too often a difficulty in getting sufficient water for the streets, whereas the sea could never run short.

The use of sea-water for flushing sewers is found to be decidedly beneficial; decomposition is retarded, and the sewers are kept cleaner and become more wholesome when salt water is present in them. The borough surveyor of Great Yarmouth, for instance, stated that his experience showed that the advantage of being able to flush the sewers with sea water was alone worth the whole cost of the works for the supply of sea-water for all purposes. His experience is that the effect of flushing with salt water has been to thoroughly cleanse the sewers, and that no nuisance from its use has been created, while, owing to its greater specific gravity, he considers it more valuable as a flushing agent. Its effect in the Yarmouth sewers has been to reduce, and, in fact, almost entirely to prevent, the generation and accumulation of sewer gas. Sewers that could not be entered by the sewer men until the manhole covers had been opened several hours can now be entered by them, and have been entered, without any inconvenience, immediately on the removal of the manhole cover.

Contract Work Not Always Desirable.

In an excellent editorial *The Engineering Record* (Feb. 15) notes a growing tendency on the part of small corporations and private owners to cut loose from the contract system in construction. What is here meant by the contract system is the method of competitive proposals for constructive work. Any one who undertakes to perform work under any sort of agreement as to price, time limit, etc., is, strictly speaking, a contractor, and his work is contract work; but, in general, contract work is understood to be work competed for in price before its allotment. This system has been attended with many evils, but it also has advantages. The advantages and evils have often been debated, the conclusion being that the system is the only one so far found which is generally applicable to government and municipal construction, although its purpose is too often defeated by official favoritism and corruption.

The *Engineering Record* says: "A New York builder is frequently given *carte blanche* to build an important building, the owner often insisting that he only shall do the work, the price paid being cost plus an agreed percentage for supervision and profit. The Broadway Cable Railway was built in this way. This condition arises partially from a special confidence in the particular contractor, but mainly from the fact that the difficulties of estimating closely on complicated work are so great that the bids will vary greatly, and the chances are about equal that the lowest bidder will be one whose ability is not well recognized, or who, from inexperience or recklessness, will take great chances and either delay the work, or, having named too low a price, slight it in the endeavor to come out ahead of his contract, or fail absolutely to carry it out, involving delay and complications in reletting.

"There are many classes of work on which it is almost impossible to estimate closely as to time as well as cost; in the case of the Broadway Cable road it was absolutely impossible to tell what difficulties or delays would be met, and, if bids were invited, they would certainly have varied greatly, and the lowest would probably be vastly in excess of the actual cost of the work, to enable the contractor to cover the chances involved.

"In the construction or reconstruction of large and valuable buildings the loss of rentals and interference with business becomes so great that excessive prices can well be paid to secure prompt results; for this reason the work on several of our great buildings has been pushed night and day at greatly increased cost. By the successful execution of such extensive and difficult work some contractors and contracting firms have secured the confidence of capitalists to such an extent that they can command their own terms and select their own work."

With reference to the general impression that contract work must necessarily be the most economical, it must be admitted that it is not groundless; and yet there may be conditions in which the very opposite would be true. It is not the ultimate cost of a piece of work that interests a contractor, so much as the prospective profit; and we think there would be few honest men who would not prefer to do a piece of work in the best manner, when assured a reasonable profit, rather than take the risks of loss which weigh against the chance of profit in contracts given on the competitive system. The following quotation is suggestive:

"The monopoly of large and difficult work, which the more powerful contracting firms deservedly possess, make it more difficult, perhaps, to secure competent men to undertake the smaller works, while at the same time it leaves room at the bottom of the ladder for the new and less wealthy contractors, who often take as much or greater interest in the small jobs as the more prominent contractors do in the large ones. A corporation with much small work on hand, embracing several classes of work in each job, has, to our knowledge, found it wise and economical to divide the work. Its engineers and architects undertake the task of connecting the several portions, and keep peace and harmony, so to speak, between the several tradesmen; the result is that a saving is effected of from ten to thirty per cent. in the cost of the work, which, under the older system of general contracts, would go to the general contractor."

The system is both convenient and economical. In many operations owners would consult their best interests by selecting a reliable contractor and allowing him a reasonable profit on cost.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Municipal Engineering in the American, English, and British Colonial Engineering and Municipal Journals—See Introductory.

Gas Supply.

*4090 The Standards of Light. W. J. Dibdin (Reviews a report made by a committee of the Board of Trade, and given after three years of careful work, recommending the adoption of Harcourt's pentone standard as preferable to any and all others that have been used or proposed. The faults of the other standards are impartially stated. Long discussion by the members of the Soc. of Arts). Gas Wld-Feb. 1. 7800 w.

*4106. Incandescent Gas Light Patents (Editorial review of important decisions of the German Patent Office. The Auer patents are sustained but their claims have been restricted. A patent to Rudolf Langhaus for the electrolytic production of an incandescent body for gas lighting was allowed). Engng-Jan 31. 700 w.

4141. The Truth About Acetylene Gas. Albert Stetson (Severely criticising the statements made in the paper read by John C. McMynn). Elec-Feb. 12. 2800 w.

*4307. A Gas-Meter Testing-Station (A sketchy description of equipment and methods in the testing-station, London, Eng.) Jour of Gas Lgt–Feb. 11. 2000 w.

4472. Incandescent Gas Light Patents. (Special correspondence of the Eng. & Min. Jour. Review of recent decisions of the German patent office in cases involving incandescent gas lighting patents). Eng & Min Jour–Feb. 29. 2300 w.

*4581. Inaugural Address of A. F. Browne, before the So. Dist. Assn. of Gas Engineers and Managers (Discusses the topics of labor-saving machinery, outside help; carbonizing coal in bulk; enrichment of hydrocarbon vapors; the question as to whether these vapors reside in the gas or in the tar; enrichment experiments; lime purification; automatic meters and gas stoves). Gas Wld–Feb. 22. 4800 w.

*4582. Inaugural Address of W. R. Cooper, before the Midland Assn. of Gas Managers (Topics discussed are the retort and its furnaces; condensation and the extraction of tar; the past and present of purification; carburetted water gas; electricity no longer a bogey; and the advantages of association). Gas Wld–Feb. 22. 6000 w.

4605. Lighting by Holophane Globes. F. Guilbert (Translated from *L'Eclairage Electrique*. An able and exhaustive scientific analysis and explanation of the action of these globes with numerous diagrams, by which the action is shown to approach very nearly the ideal photometric curve in the distribution of light). Pro Age-March 1. Serial. 1st part. 2500 w.

4606. On the Poisonous Properties of Acetylene. Dr. Rudolf Rosemann (From the *Journal of the Pharmacological Inst. of the University of Greifswald.* Describes minutely, from notes of observations made at frequent intervals, the effects of acetylene upon vital functions, when inhaled by animals Twelve experiments were made. In one of these, thirty-two observations were taken of the vital conditions of the animal, before death was produced). Pro Age–March 1. 7000 w.

4702. The Production of Cyanide in Gas Works (Illustrated description of process and apparatus). Am Mfr & Ir Wld–March 6. 700 w.

4703. The Development of Candle Power. W. S. Allen (Paper read at the twenty-sixth annual meeting of the New England Assn. of Gas Engs. Treats of the demand for higher candle-power and some of the less well known methods of obtaining higher candle power in gas, with discussion). Am Gas Lgt Jour–March 9. 3300 w.

4704. Acetylene Gas. Walter R. Addicks (Describes the manufacture of calcium carbide as carried out at Spray, N. C. Considers the qualities of the product, and the possibilities, as well as practicabilities of acetylene as a factor in the manufacture of gas). Am Gas Lgt Jour–March 9. 10000 w.

Sewerage.

*4146. The Present European Practice in Regard to Sewage Di-posal. Allen Hazen (A general review of the subject). Jour of Assn of Eng Soc–Dec. 8000 w.

4216. Underdrainage Purification Plant, Sewerage System of South Framingham, Mass. (Illustrated description). Eng News–Feb. 13. 1100 w.

4219. The Dislocation of a Brick Sewer in Soft Ground, at Lynn, Mass. (Description, with engraving, and proposed remedy). Eng News–Feb. 13. 400 w.

4301. Report on the Sanitary Needs of Cleveland, O. (An interesting and instructive document). Eng Rec–Feb. 15. 1200 w.

4473. Gagings of the Dry Weather Flow of Sewage at Des Moines, Ia. J. A. Moore and W. J. Thomas (A compilation of data from records of various sewer-flow gagings in American cities. Illustrated description of apparatus for gaging flow, and a diagram of hourly pumpage and sewer-flow at Des Moines, June 30 to July 16, 1895). Eng News–Feb. 27. 3800 w.

4478. The Operation of the Brockton Sewage Filter Beds in 1895 (Information on the subject of sewage filtration derived from observation of the results attained in the filter beds at Brockton, during the past year. The disposition of the sewage, without offensive odors, is as yet not satisfactorily effected at Brockton). Eng News–Feb. 27. 2300 w.

*4504. The Richmond Drainage and Sewage Works (A popular description of the plant and process of treatment). Mach, Lond–Feb. 15. 2500 w.

*4534. Sewage and Zymotic Poisons. James Hargreaves (Read before the Liverpool Polytechnic Society. Poisons are divided into three classes—elemental, organic or quasi-organic, and organized, self-propagating or parasitic poisons,—this class being that for which sewage supplies the elements for propagation, and which therefore includes the zymotic poisons with which the author deals. Methods by which these poisons are propagated and diffused, and means for their prevention are described). San Rec–Feb. 21. 3200 w.

*4535. System of Syphon and Refuse Holder for Street Gullies (Illustrated description of a French water trap system whereby odors and gases from sewers are prevented from gaining access to the air in streets). San Rec-Feb. 21. 1300 w.

Streets and Pavements.

4498. Paving Country Highways. William S. Williams (The author discusses the application of brick paving to public highways, and finds it good). Clay Rec–Feb. 26. 900 w.

*4548. Cleaning and Watering of Streets in Paris. Alfred Perkins Rockwell (Extract from "Roads and Pavements in France," just published by John Wiley & Sons, New York. Subject is discussed under these heads: (1) The removal of mud and household refuse, which is done by contract. (2) Sweeping and watering, done exclusively by the street-cleaning department, except that sand and the use of some sweeping machines are obtained by contract. (3) Removal of snow and ice. Description of means and methods are given). Pav & Mun Eng–March. 1300 w.

4591. Needed Legislation on the Drainage of Public Highways. B. B. McGowen (Suggestions which the writer thinks would secure good roads the year around; followed by discussion). Brick-March. 2500 w.

4593. Paving Country Highways. Captain Williams (Favoring the movement). Brick-March. 1100 w.

4594. Brick Pavements the Best. M. H. Underwood (In favor of vitrified brick, laid on a concrete foundation). Brick-March. 3300 w.

Water Supply.

4152. The Montreal Water-Works. John Kennedy (History and general description, including the aqueduct and pumping machinery). Can Eng-Feb. 8000 w.

4220. Future Water Supply of Greater New York. (An exhaustive editorial discussion of what is growing to be a serious problem. It is computed that by the year 1920, no less than 600,000,000 gals. daily will be needed, and there is a strong probability that the daily demand may reach 1,000,000,000 gals. The supply and distribution of this enormous amount of water will demand the highest skill and forethought). Eng News-Feb. 13. 2400 w.

4302. The Newton, N. J, Water-Works (Illustrated detailed description). Eng Rec-Feb. 15. 3300 w.

†4349. Notes on the Underground Supplies of Potable Waters in the South Atlantic Piedmont Plateau. J. A. Holmes (The topic of the relative purity of surface water and that from deep wells is first discussed and the limited availability of deep artesian wells is then presented, and the tube-well system is commended as adapted to the plateau in question). Trans Am Inst of Min Engs-Feb. 2800 w.

*4377. The Purification of Water by Means of Metallic Iron. F. A. Anderson (A good popular description of the process as carried out at different installations in various cities in Europe). Jour Soc of Arts-Feb. 14. 8000 w.

4394. The Nashua Aqueduct (Illustrated detailed description forming part of the works intended to supply the metropolitan district of Boston). Eng Rec-Feb. 22. 2400 w.

4476. The Water Supply and Water Consumption of Philadelphia (Graphic representations of water supply and consumption and of various estimates of future consumption, with explanatory text). Eng News-Feb. 27. 1400 w.

4479 Nordberg Compound Pumping Engine. New Kensington, Pa (Illustrated detailed description). Eng News-Feb. 27. 2500 w.

Miscellany.

*4086 Standpipes for Fire Protection and Street Flushing. Louis L. Tribus (Describing a method of dispensing with steam fire engines by the substitution of hose companies, and at the same time increasing the safety of property and life). Eng Mag-March. 3000 w.

*4117. The Supply of Sea-Water to London. Frank W. Grierson (A paper read at the meeting of the Soc. of Arts. It gives a general description of the plan of supply, with remarks on its use for municipal purposes, hospitals, schools, hotels, residences, etc., showing the saving of fresh water, and a summary of the advantages). Arch, Lond-Jan. 31. 3300 w.

4223. Reports on an Additional Water Supply for Brooklyn, N. Y. (Difficulties experienced in keeping up supply to meet increased demand. Editorial review of Mr. De Varona's report on what is known as the "Long Island Plan," and of Mr. Worthen's reports on the "Housatonic or Ten Mile River Plan," and the "Ramapo and Walkill Plan," followed by a comparison of these three plans, and comments by Mr. Alfred T. White). Eng News-Feb. 13. 5000 w.

*4288 Investigation of Electrolysis at St. Louis (From the annual report of the supervisor of city lighting at St. Louis, telling of steps taken to learn the extent and to prevent electrolysis). St Ry Rev-Feb. 15. 450 w.

4300. Contract Work not Always Advisable (A good editorial on the growing tendency to avoid the contract system). Eng Rec-Feb. 15. 900 w.

*4308 The Welsbach Patents in Germany (Summary of the official decision in the nullity suit). Jour Gas Lgt-Feb. 11. 2700 w.

4346. The Final Disposition of the Wastes of New York City (Abstracts of advance sheets of a forthcoming report, on the disposal of garbage, street-sweepings, store and other refuse of New York, by Col. G. E. Waring, Com. of Street Cleaning). Eng News-Feb 20. 600 w.

4392. Franchises for Small Municipalities (Editorial. The carelessness with which franchises for small municipalities are granted, and the resulting evils, are the burden of this able article). Eng Rec-Feb. 22. 900 w.

4474. An Ordinance to Prevent Electrolysis of Water and Gas Pipes at Richmond, Va. (Full text of an ordinance approved Jan. 23, 1896. Will be a guide to similar legislation in other municipalities). Engng News-Feb. 27. 1400 w.

*4546. Production of Asphalt in the United States (Statistics compiled from the sixteenth annual report of the U. S. Geol. Surv). Pav & Mun Eng-March. 800 w.

*4547. The Contractor's Fair Profit. J. H. Burnham (Abstract from address before Illinois Soc. of Surv. & Engs. The fact that contractors often fail to secure a fair profit is noted, and reasons for such failure are given. This is followed by hints intended to help in securing the opposite result). Pav & Mun Eng-March. 2300 w.

*4549. Essential Features of a Park System (Abstract of a report suggesting plans for a park system, in which essential features are outlined by a distinguished firm of landscape architects). Pav & Mun Eng-March. 2500 w.

†4579. On the Use of Acetone in the Technical Analysis of Asphaltum. S. F. Peckham (A comparison of tests of acetone and of petroleum ether in parallel experiments, with a statement of results from which the author concludes that acetone cannot be made an equivalent for petroleum ether in the technical analysis of asphaltum). Jour Fr Inst-March. 1200 w.

RAILROADING

Articles of interest to railroad men will also be found in the departments of Civil Engineering, Electricity, and Mechanical Engineering.

The Sand Track Derailer.

It sometimes happens that locomotives become unmanageable and run off; or that signals are disregarded; or that brakes refuse to work; or that from similar causes trains crash through open draws or collide with other trains. Derailing-switches prevent such accidents on side-tracks, but the following method from the *Scientific American Supplement* (March 7) fills a decided void in main-track devices:

"As is known, there are in use on the English railways, for the protection of main lines, switches, throwing from the main line cars which come from side-tracks at improper times. Such switches, called 'throw-offs,' are connected with the signal in such a manner that the latter cannot allow the passing of a train to the main line, the throw-off switches sending it into the sand on ballast. In case of a car moving on the siding in the direction of the main line, it will be thrown off the main line in time to be stopped by the resistance of the ballast.

"This way of stopping cannot be employed for trains on main lines, because it would bring about destruction not less shocking than that which it would be intended to prevent. Therefore it is necessary to make the leaving the main rails an entirely safe measure before it can be recommended as a means of safety.

"This may be done by guiding the train to be stopped, not into the ballast, but on a separate track, the rails of which are covered with a layer of sand; the switch leading to this track to be coupled with the signal before which, when it stands at danger, the train should stop. A second switch may serve as an outlet into the main track to avoid backing the stopped train. This safety siding, being always covered by a layer of sand, is not dependent for its efficiency on the engine runner, nor on an apparatus for strewing sand, nor on the watchman for throwing impediments on the rails.

"Tests have been made of the effect of the sand tracks on a track having a grade of 1 in 100. Wooden guard sleepers are placed between the rails, leaving a gutter for the wheel flanges and rising five centimeters (=two inches) above the level of the rails. These guard sleepers serve both to secure the wheels against leaving the rails and to level the sand layer. The cars were set in motion by a shunting engine, and accelerated by the grade of 1 in 100.

TABLE OF RESULTS OF TRIALS.

No.	No. of cars.	Veloc'y meters per second.	Distance in sand, in meters.		P'tential en'gy.	Coefficient of resistance. f
			a	b		
1	2 empty	3.75	7	17.6	1.082	0.0880
2	8 empty	5.882	13.6	72.0	2.841	0.066
3	10 loaded	7.692	45.0	117.2	4.422	0.0543
4	10 loaded, 3 empty	8.823	36.4	130.6	5.638	0.0675
5	9 loaded	10.0	78.2	112.6	6.870	0.0622
6	9 loaded	12.5	101.0	165.0	10.113	0.0760

"The thickness of the sand layer was 5 cm for numbers 1 to 4, and 8 cm. for numbers 5 and 6.

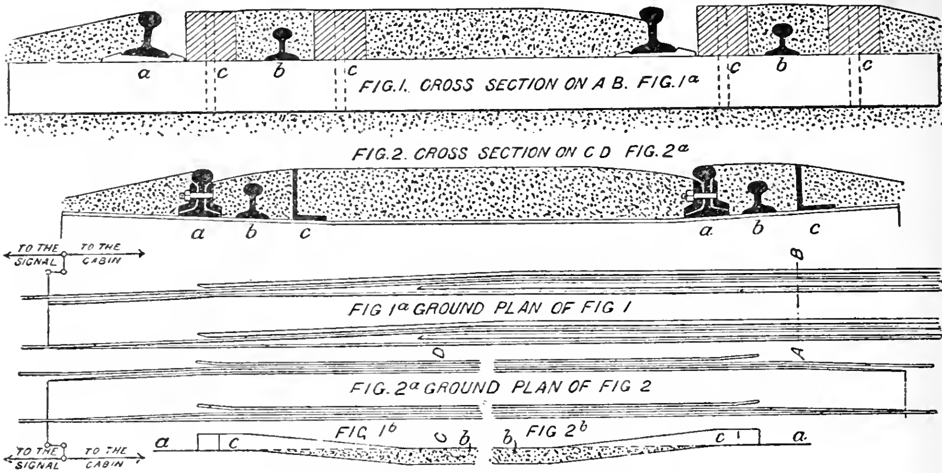
"As an example of the manner of calculation of the coefficient, we may use the first trial.

"Example: The empty cars with the velocity of 3.75 meters per second came to a standstill after having run in the sand track with the first axle a distance of 17.6 meters, with the last one 7 meters; the mass of the rotating parts considered as at the circumference of the wheels was 16 per cent. of the entire mass of the cars (axles and wheels included); what was the friction?

"Solution: By substituting the given numbers in the equation we get

$$f=\frac{0.075+\frac{17.6}{100}+\frac{1.16\times3.75^2}{2\times9.81}}{\frac{7+1.7\times6}{2}}=\frac{1.082}{12.3}\text{ ; } f=0.088.$$

"From all the trials it has been proved that the retardation in the sand track is quite continuous and without any jerk.



KOPCKE'S SAND TRACK.

The buffers are pressed in gradually, and there was never remarked any tendency to lift an empty car placed between loaded ones, although there was often, by reason of the load, considerable difference of height of the buffers.

"Tests were also made during a cold spell with 10° below zero Centigrade (= + 14° F.) The sand layer of 8 cm. thick was frozen after having been sprinkled, forming a middling solid mass. Under these circumstances the sand track worked well, as the cars (7 empty and 1 loaded) ran into it without dangerous acceleration."

The sand best adapted for this is one which will not pack. The article includes other problems and formulæ for which space cannot be here given.

Profits of American and British Railways.

In an editorial, *Engineering* (London, Feb. 14) discusses some of the causes which have made American railway securities such poor dividend-payers. The comparison is interesting as coming from good authority and being derived from accurate reports. We abstract some of the most interesting parts:

"The total mileage in the United States is 180,000, and the probabilities are that, in view of the low dividends, the additions each year will be less, for the lowness of the return on existing lines is more operative on the public mind than sanguine estimates of probable gain from new lines. It is true that there is only one mile of railway to 20 square miles of area, whereas in Britain we have one to 5.8 square miles. But this standard of comparison, so often adopted, is misleading. It were better to consider population and trade. In Britain there are 1,846 inhabitants per mile, and in the States barely 350, while the value of foreign trade, imports and exports, works out to over £30,000 per mile of railway in Britain, and to £1,900 per mile in the States. Of course the consumption of home products is an element in the consideration, but it must be remembered that the population of the United States is not double that of the United Kingdom, while the railway mileage is nearly nine times.

"The railway results themselves seem to show benefit to the trader rather than the shareholder, no matter from what standpoint these are examined. The interest paid on stock last year was 1.64 per cent.,—10 years ago it was 2¾ per cent.,—whereas in this country the return on ordinary capital is equal to 3½ per cent. The United States is not by any means so compact a country as this, but, at the same time, it should be remembered that this reason makes our roads the more expensive, so that the average capital per mile in this country is nearly five times as great as in the United States. In other words, each mile in this country must show a net profit five times as great as in the United States to pay the same dividend. As a matter of fact, each mile in this country earns in net profit nearly £1,800, against £362 in the United States. But the difference in the gross earnings per mile open is not so great, being in the United States £1,217, while in this country it is £4,000, so that it will be recognized that our system is worked more successfully. In other words, 43 per cent. of our total receipts is profit; in the States barely 30 per cent. is thus retained."

Speaking of the passenger traffic, he says that "it is somewhat interesting to note that, although the total length of railroad in the States is 8½ times that in this country, the passenger train-mileage is not double. In other words, each mile of railway in this country is, on the average, traversed 8,600 times in the year by passenger trains, while in the States it is only covered about 1,900 times. This is, of course, due to the number of passenger trains in the far west seldom exceeding four per day; and in many cases a passenger car is only attached to the freight trains; so that it will be at once apparent that British conditions cannot obtain.

"The average fare per mile does not differ very much, but is rather less in the United States. There it is 1d. (2.03 cents) per mile, but in the more important districts ¾d. only. In this country the third-class passenger predominates to such an extent as almost to make the extra charge on first- and second-class passengers inoperative in effect, so that it may be taken that the rates are about the same.

"Our goods traffic receipts per mile of road is enormously greater,—£2,280 against £800. Again, our volume of goods traffic per mile of road is greater, being 15,500 tons against 3,848 tons in the States. It will be recognized that the difference is greater in volume than in receipts, indicating that in the United Kingdom the revenue is less per unit of volume than in the States. The fact that the average haul of each unit of volume is much greater in the States than here more than accounts for this. Our freight train mileage per mile of road is 7,150 against 2,700 miles in the States, but our total excludes mixed trains, which are ranked separately in the board of trade return. In other words, considered per mile of road, Britain runs three times the number of trains for four times the volume of traffic, and receives less than three times the gross revenue for goods. The average rate is notoriously higher, the haul is very much shorter. The average receipts per ton per train-mile in the States are .425d., and the average length of haul 121.89 miles. The latter in this country is far less. The receipts per goods train-mile are 73.62d.; in Britain, excluding mixed trains, 70d. Each United States train-mile represents 173 ton-miles at .42d. per ton. Similar figures are not given in the board of trade return. But it is very evident that the rates in the United States are much lower, so that the railways have to undertake heavier duty to make the gross revenue per train-mile the same.

"Including all revenue and all train mileage, the receipts per train-mile are in the United States 5s. 5¼d., in the United Kingdom 4s. 9½d.,—a difference of 7¾d. per train-mile. But this involves heavier duty in the United States in greater proportion than is indicated by the receipts, not only for the locomotives, but more especially in terminal charges, notwithstanding the long haul. And this in some measure accounts for the fact that in the States 70.24 per cent. of the revenue is absorbed in expenses. This is some 10 per cent. higher than in any of our Australian colonies, where the conditions are as unfavorable as in the States. In Britain, where legislation adds many costly conditions, the percentage has never exceeded 57. The result is that, instead of getting a net profit per train-mile of 2s. 1d., the United States railways only obtain 1s. 7½d. In other words, it costs them 1s. more for each mile run by a train."

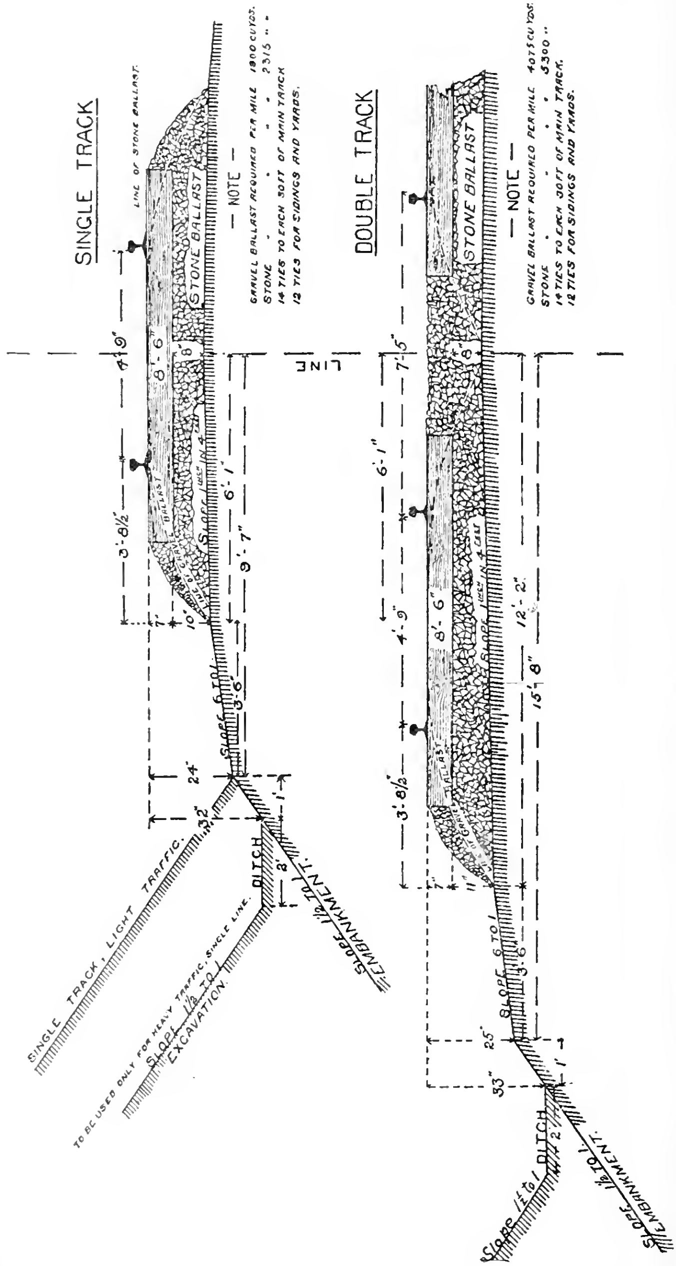
Road-bed Specifications.

In discussing the subject of street-railway roadbeds, Mr. Mason D. Pratt, in the *Street Railway Journal* (March), gives the specifications of the Pennsylvania Railroad as a good index to what a good road-bed should be and as a basis for similar street-railway specifications.

"*Road bed.*—The surface of the road-bed should be graded to a regular and uniform sub-grade, sloping gradually from the center toward the ditches.

"*Ballast.*—There shall be a uniform depth of from six to twelve inches of well-broken stone or gravel, cleaned from dust by passing over a screen of one-quarter inch mesh, spread over the road bed and surfaced to a true grade, upon which the ties are to be laid. After the ties and rails have been properly laid and surfaced, the ballast must be filled up, as shown on standard plan, and also between the main tracks and sidings, where stone ballast is used. All stone ballast is to be of uniform size, and the stone used must be of an approved quality, broken uniformly, not larger than a cube that will pass through a 2½-inch ring. On embankments that are not well settled, the surface of the road-bed shall be brought up with cinder, gravel, or some other suitable material.

"*Cross ties.*—The ties are to be regularly placed upon the ballast. They must be properly and evenly placed, with ten inches between the edges of bearing surface at joints, with intermediate ties evenly spaced; and the ends on the outside on double track, and on the right hand side going north or west on single track, lined up parallel with the rails. The ties must not be notched under any circumstances; but, should they be twisted, they must be made true with the



CROSS SECTIONS OF SINGLE AND DOUBLE TRACK CONSTRUCTION—PENNSYLVANIA RAILROAD.

adze, that the rails may have an even bearing over the whole breadth of the tie.

"*Line and Surface.*—The track shall be laid in true line and surface; the rails are to be laid and spiked after the ties have been bedded in the ballast; and, on curves, the proper elevation must be given to the outer rail and carried uniformly around the curve. This elevation should be commenced from 50 to 300 ft. back of the point of curvature, depending on the degree of the curve and speed of trains, and increased uniformly to the latter point, where the full elevation is attained. The same method should be adopted in leaving the curve.

"*Joints.*—The joints of the rails shall be exactly midway between the joint ties, and the joint on one line of rail must be opposite the center of the rail on the other line of the same track. A Fahrenheit thermometer should be used when laying rails, and care taken to arrange the openings between rails in direct proportion to the following temperatures and distances: at a temperature of 0 deg., a distance of 5 16 in.; at 50 degs., 5-32 in.; and in extreme summer heat, of, say, 100 degs. and over, 1-16 in. must be left between the ends of the rails to allow for expansion. The splices must be properly put on with the full number of bolts, nuts, and nut-locks, and the nuts placed on inside of rails, except on rails of sixty pounds per yard and under, where they shall be placed on the outside, and screwed up tight. The rails must be spiked both on the inside and outside at each tie, on straight lines as well as on curves, and the spikes driven in such position as to keep the ties at right angles to the rails.

"*Switches.*—The switches and frogs should be kept well lined up and in good surface. Switch signals must be kept bright and in good order, and the distant signal and facing point lock used for all switches where trains run against the points, except on single-track branch roads.

"*Ditches.*—The cross section of ditches at the highest point must be of the width and depth as shown on the standard drawing, and graded parallel with the track, so as to pass water freely during heavy rains and thoroughly drain the ballast and road-bed. The line of the bottom of the ditch must be made parallel with the rails, and well and neatly defined, at the standard distance from the outside rail. All necessary cross drains must be put in at proper intervals. Earth taken from ditches or elsewhere must not be left at or near the ends of the ties, thrown up on the slopes of cuts, nor on the ballast, but must be deposited over the sides of embankments. Berm ditches shall be provided to protect the slopes of cuts, where necessary. The channels of streams for a considerable distance above the road should be examined, and brush, drift, and other obstructions removed. Ditches, culverts, and box drains should be cleared of all obstructions, and the outlets and inlets of the same kept open to allow a free flow of water at all times.

"*Road Crossings.*—The road crossing planks shall be securely spiked; the planking on inside of rails should be ¾ inch, and, on outside of rails should be ⅛ below the top of rail and 2½ inches from the gage line. The ends and inside edges of planks should be beveled off, as shown on standard plan."

The Division Superintendent.

In an editorial commenting upon an article printed on another of its pages the *Engineering News* (Jan. 9) remarks upon the duties of a railway division superintendent as follows:

"It may be explained that the superintendent is in practical charge of the operating service of the railway, and on all roads of any importance there is one general superintendent, whose jurisdiction is over the entire line, and several division superintendents, each having jurisdiction over a certain division of the line. Two different systems are in use, with respect to the powers and duties of the division superintendent. In the first, he is given absolute control over his division, being the superior officer of the divisional force. In the second, he is merely a departmental head, ranking with the division master mechanic and the division engineer or road master. In this latter case he is practically little more than a train-master or superintendent of train service, and has little or no absolute authority, having to refer all matters of detail to the superior authority at headquarters, which authority has no personal knowledge of the local conditions or affairs. Under such conditions of divided authority there will almost of necessity be a great deal of formality and delay in regard to the everyday matters of the service, with consequent loss of time, money, and opportunities, and with probably more or less friction between the officers. This is not only the case in the dealings between the public and the railway, but also in the operating details. Thus, if the superintendent wants to send a work-train out to any part of his division, he has to apply to the motive-power department for an engine, and may not get an engine suitable for the service required. Similarly, if any part of the track requires prompt attention, a communication may have to be made to the general superintendent and then referred to the general manager, from whose office it is again referred to the chief engineer or head of the maintenance-of-way department, and thence through subordinate channels.

"By far the better practice, as is now very generally recognized, is to make the division superintendent the man in direct charge of the division, with power over all departments. Under such conditions he reports only to the general superintendent, but he is, of course, compelled to observe and abide by the general regulations and the standards of construction, etc., adopted by the company. On the Erie R. R., the division superintendent is in charge of the entire equipment and work of the division, including the maintenance of way, the providing and caring for the motive power and equipment, and the movement of passenger and freight traffic. He has under him a train-master, chief train dispatcher, road-master, and master mechanic, and he reports to the general superintendent and the superintendent of transportation. The higher officials are, therefore, not compelled to attend to matters of detail referred to them from various divisions, but all such matters are attended to directly by the local authority, who is conversant with all the affairs of his division. Records and accounts are, of course, kept by the general superintendent, and monthly statements are usually prepared, showing the traffic, expenditures, etc., of each division, so that a comparison may be made as to the efficiency and economy obtained on different divisions."

Electric Friction Brakes.

IN the *Street Railway Review* (March) Mr. A. K. Baglor recommends electric power braking for street cars and describes the mechanism thus:

"The commercial form into which this type of brake seems to have resolved itself consists of a circular iron plate made fast to the axle and turning with it in a plane parallel to that of the wheel, together with an electro-magnet, also in the form of a disk, which is held so that it cannot revolve. This magnet when energized is brought into close contact with the axle-disk, the resulting friction retarding the latter (and with it the car wheels), while at the same time the generator action going on in the motors tends to bring the armatures to rest. The magnetic friction method is to be preferred, as by its use all forces tending to propel the car are opposed directly and simultaneously, reducing all internal strains to a minimum, and bringing the vehicle to rest in the least possible time."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Railroad and Engineering Journals—See Introductory.

*4088. The Railroad Facilities of Suburban New York. Ill. Foster Crowell (Discussing the probable development of means of transit for the accommodation of districts surrounding New York within a thirty-mile radius). Eng. Mag-March. 4200 w.

*4099. After the Great Railway Race. Charles Rous-Marten (A summary of details of some of the fast runs on English roads, with some reference to American records). Eng, Lond-Jan. 31. 4500 w.

4114. Oriental Railways. Clement F. Street

(The writer visited Tunis, Egypt, and India, securing information for the Commission on World's Transportation of the Field Columbian Museum, and in this well illustrated description gives the results of his observations). Ry Rev-Feb. 8. Serial. 1st part. 3800 w.

4115. Home for Aged and Disabled Railroad Men. L. S. Coffin (An interesting letter to the editor from a R. R. President, showing how care may be taken of the helpless employees). Ry Rev-Feb. 8. 900 w.

4134. Electricity on the New York Elevated Railroads (A combination of third rail and storage battery to be tried). Elec Eng-Feb. 12. 1500 w.

4135. Electric Motors on the Brooklyn Bridge. Ill. (An account of the first official test of electricity as applied to the switching of the cars on the bridge). Elec Eng-Feb. 12. 1000 w.

*4147. Solid Floor Bridges for Railroads and Highways. Frank C. Osborn (Read before the Civ. Eng's Club of Cleveland. The author describes and illustrates all the principal forms of this construction that have been used; it is an interesting record of what has been done). Jour of Assn of Eng Soc-Dec. 11000 w.

†4153. The Cause of Train Detentions (Discussion. The causes are itemized and their relative frequency indicated in per cents). N. Y. R R Club-Dec. 19. 7000 w.

†4181. European Railroads: Mileage and Speed (Statistics showing that the average speed of express trains in Europe varies from 43.49 to 52.43 miles per hour. Reference is made to the late record-breaking runs). Con Rept-Jan. 700 w.

4184. Train Accidents in the United States in 1895 (Statistics covering a period of 22 years, classified according to causes; also figures for the year 1895, by months, with causes). R R Gaz-Feb. 14. 1100 w.

4185. The Stickney Track Indicator. Ill. (The instrument is attached to the bottom of the car and records automatically any sudden divergence from a straight line motion). R R Gaz-Feb. 14. 350 w.

4193. The Schuylkill Electric Railway (Illustrated description of railway at Pottsville, Pa) Elec Ry Gaz-Feb. 15. 1000 w.

4194. Mr. Sprague on Underground Rapid Transit. From the *N. Y. Evening Post* (An account of an interview with Mr. Frank J. Sprague). Elec Ry Gaz-Feb. 15. 1500 w.

*4197. Electric Traction in the Light of Recent Developments. Philip Dawson (Illustrated account of progress of electric traction in Europe). Elec Rev, Lond-Feb. 7. 1800 w.

4211. Snow Sheds of the Central Pacific R. R. (An illustrated description of the sheds, and the system employed to lessen damage by fire in the sheds, and consequent delay of traffic). Safety V-Feb. 900 w.

4212. Contributory Negligence (Claim for injuries caused by negligence of claimant and of fellow employé. A legal question). Ry Age-Feb. 15. 1500 w.

4221. Switching by Electricity at the Brooklyn Bridge Terminals. Ill. (The switching locomotives will be abandoned and one car of each train will be supplied with electric motors which will furnish driving power at the terminals, after the cable is dropped). Eng News-Feb. 13. 2300 w.

4222. The Relative Cost of Car Lighting by Pintsch Oil Gas and by Compressed City Gas (The tests show that for equal illumination compressed city gas costs 2½ times as much as Pintsch gas). Eng News-Feb. 13. 350 w.

4224. Rail Sections and Wheels (Abstract of a paper read by Mr. Lodge at the meeting of the Engng. Assns. of the South, at Nashville. The writer discusses the relative wear of wheel and rail head and the influence of changing the quality of each). Eng News-Feb. 13. 1100 w.

*4237. Steel Sleepers. James Whitestone (A communication to the editor discussing the objections raised against steel railway ties, and comparing them with ties of wood). Eng, Lond-Feb. 7. 1600 w.

*4243. The Old Bodmin and Wadebridge Railway (An article of historic interest, giving views of a number of old cars). Ry Wld-Feb. 1400 w.

*4244. Westinghouse Enclosed Conduit System for Electric Traction (An illustrated description. The car takes the current from spaced contact pins in road bed). Ry Wld-Feb. 1600 w.

*4256. Railway Charges in the Iron and Coal Industries (An excellent discussion showing the difference between English, continental and American railway rates. It is stated that English railways will have to earn nine times the amount earned by American railways in order to pay the same dividends). Ir & Coal Trs Rev-Jan. 31. 1500 w.

4264. Trucks for Lake Street Elevated Electric Motor Cars (Three designs are illustrated). Ry Rev-Feb. 15. 1500 w.

4270. Can Electricity Supplant the Steam Locomotive on Trunk Railways? William Baxter, Jr. (The object of the writer is to present the merits upon which electricity can base a claim of superiority in a fair and impartial manner. The first part is largely introductory). Elec Eng-Feb. 19. Serial. 1st part. 900 w.

4285. Hot Boxes (The article includes a number of useful practical hints). Age of St-Feb. 15. 1500 w.

*4289. Cedar Rapids and Marion City Railway. Ill. (Description of a well managed electric railway). St Ry Rev-Feb. 15. 1500 w.

4315. The Transportation Problem in New York City (Suggestions for increasing the facilities of the elevated roads, the Broadway cable road, and the Brooklyn bridge road). Sci Am-Feb. 22. 1800 w.

*4321. Specifications for Steel Rails of Heavy Sections Manufactured West of the Alleghenies. Robert W. Hunt (A revision of the author's specifications of 1888, with additional clauses covering chemical composition and drop tests). Trans Am Inst of Min Engs–Feb. 2800 w.

4343. Central Water Supply Stations for Railways. Charles A. Hague (Illustrated description of supply well and stand-pipe supply of the Long Island (N. Y.) R. R). Eng News–Feb. 20. 1400 w.

4357. The Ninety and Nine J. N. Barr (A paper read before the Western Ry. Club. The writer shows the danger of neglecting the other departments while pursuing one that is inefficient, going into very interesting details). R R Gaz–Feb. 21. 2500 w.

*4361. Railway Accidents and Their Causes (Editorial discussion of particular cases). Trans–Feb. 14. 1800 w.

4378. Gross and Net Railroad Earnings in 1895 (Tabulated statement of the gross earnings and the net earnings of each road separately for each of the past three years). Bradstreet's–Feb. 22. 1000 w.

*4382. The Life of Iron Railway Bridges (An editorial discussion). Eng, Lond–Feb. 14. 2200 w.

4388. The Daily Car Situation. J. R. Cavanagh (Read at a meeting of the Indianapolis Div., Central Assn. of R. R. Officers. Suggestions as to forms governing the movements of cars). Ry Age–Feb. 22. 1000 w.

*4391. The Modern Locomotive. William Rowland (Paper read before the Liverpool Univ. College Engng. Soc. Calculations and considerations determining details in the design of locomotives). Prac Eng–Feb. 14. Serial. 1st part. 4300 w.

4404. European Practice in Overhead Trolley Construction (The European device is a sliding contact collector, and while it appears cumbersome, it possesses many excellent features). W Elec–Feb. 22. 1100 w.

*4414. The Profits of United States Railways (Editorial. Some interesting comments upon American railway securities. Compares the rates, traffic, etc., on American with that on English roads. The editor offers an explanation as to why the stocks are dealt in principally from a speculative point of view, in the London market). Engng–Feb. 14. 2500 w.

4426. State Control of Railroads vs. the Obligation of State Protection. President Blackstone (From the annual report of the president of the Alton R. R. The facts presented are of interest to all railroad managers). Ry Rev–Feb. 22. 2500 w.

4427. Air Brake Instruction Car—Michigan Central Railroad (Illustrated description). Ry Rev–Feb. 22. 600 w.

4433. Boston's Great Street Railway System. H. G. T. (Largest and best equipped service; —the "west end" and what it has done for Boston and her suburbs;—a brief outline of the system and its operation). Elec Rev–Feb. 26. 3400 w.

4449. The Westinghouse-Baldwin Electric Locomotive (Illustrated description). Elec Eng–Feb. 26. 500 w.

4450. Test of Rail Bonds (Results of some tests made by Mr. Robert Bunning, Master Mechanic of the Buffalo Railway Company. All the instruments were of the Weston type, and had just been recalibrated by the Weston Co). Elec Eng–Feb. 26. 400 w.

4482. The McMahon Dump Car. Ill. (A simple positive action, downward thrust device which forces open the drop doors, thus obviating the annoyance due to the chains usually employed, freezing fast to the coal and refusing to let the doors open). R R Gaz–Feb. 28. 1000 w.

4483 The Carriage of Bicycles (Editorial comment giving both sides of the question). R R Gaz–Feb. 28. 1300 w.

*4484. The Docteur System of Fireboxes with Firebrick Walls (From a paper by M. Docteur published in the *Revue Universelle des Mines*. The paper is well illustrated and the results of the experiments are given in detail. A saving of from 10 to 12 per cent. in fuel is claimed). Am Eng, Car Build & R R Jour–March. 2400 w.

†4524. The System of the Portland Railroad Company (The power station is fully described and illustrated by views and sections. It was intended as a model of its kind). St Ry Jour–March. 2500 w.

†4525. Some Recent Electric Railways in France (Illustrated description of two roads one between Roubaix and Tourcoing, the other between Raincy and Montfermeil). St Ry Jour–March. 1000 w.

†4526. Experience with the Electric Locomotive in Baltimore. Lee H. Parker (Considerable itemized data is given along with the considerations causing electricity to be adopted). St Ry Jour–March. 3200 w.

†4527. The Reasons Why Electric Motors Will be Used on the Brooklyn Bridge (The reasons why electric motors will displace the switching locomotives is fully discussed and views presented showing the bad effects of locomotive gases and the terminal arrangement). St Ry Jour–March. 1800 w.

†4528. Recent Work of the Boston West End Street Railway Company (The installation possesses many interesting features, among which are wrought steel fly-wheels, and the use of direct connected generators. Drawings of fly-wheel, stack and power-house arrangement accompany the article). St Ry Jour–March. 1400 w.

†4529. Why the T Rail Is not Satisfactory on Paved Streets in San Francisco. S. L. Foster (Excessive wear of the pavement adjacent to the rail was prevented by a flat rail laid on a redwood stringer, inside the rail, which then attracted the heavy traffic of drays). St Ry Jour–March. 900 w.

†4530. Power Brakes Upon Electric Cars. A. K. Baylor (The author shows how the revolving armature on the car axle may generate the power requisite for braking the car, after the driving current is shut off). St Ry Jour–March. 3000 w.

†4531. Rail Bonds (The best forms of bonds are described and illustrated). St Ry Jour–March. 2600 w.

4539. More European Street Railway Tickets. Ill. Robert Grimshaw (Descriptive of tickets used in various places in Europe). Elec Ry Gaz–Feb. 29. Serial. 1st part. 1200 w.

*4555. Japanese Railways (A report upon the condition and extent of railway development containing interesting statistics. On March 31, 1894, there were 1938 miles of operating railways and 994 miles projected). Engng–Feb. 21. 1800 w.

*4561. The Midland Railway Company's Automatic Steam and Vacuum Brake (A very clear diagram drawing of the locomotive vacuum brake in detail, to which is appended a description). Eng, Lond–Feb. 21. 1500 w.

4638. The Baldwin-Westinghouse Electric Locomotive (A careful account, with illustrations, of the truck and general plan of the framing of the standard electric locomotive designed for, and built by the Baldwin-Westinghouse combination. This is apparently one of the most important steps yet taken towards the development of an electric locomotive for use on trains of considerable weight and speed). R R Gaz–March 6. 3000 w.

4639. The Question of Large Cars (An abstract of a report by a special committee of the New York Railroad Club on the important subject of an agreement for limiting the size of freight cars. The question is whether it is desirable or whether it is practicable to reduce the number of types of cars built and to keep the sizes down to specified maximum limits. The committee recommends keeping box cars down to 70,000 lbs. capacity and open cars to 80,000). R R Gaz–March 6. 2500 w.

4640. Testing the B. & O. Electric Locomotive (Extracts from a report by Mr. Lee H. Parker, engineer in charge of electric installation, on some of the performances of the heavy electric locomotive recently built for service in the Baltimore tunnel, wlth diagrams showing current and draw-bar pull). R R Gaz–March 6. 1500 w.

4641. Discipline on the Louisville and Nashville (An editorial giving considerable account of certain important modifications of the usual methods of discipline for railroad employees, as put in practice on this road). R R Gaz–March 6. 1500 w.

*4643. Roanoke Machine Shops. Ill. A. S. (The description includes some ideas which are of value to railroad men as being very good practice) Loc Engng–March. 1200 w.

*4644. Southern Railway Shops at Knoxville (An illustrated description). Loc Engng–March. 2700 w.

*4645. Central Railway of Brazil. Lewis Gleason (A lengthy description of the location, organization, operation, equipment, etc., of a very interesting road). Loc Engng–March. 5500 w.

*4646. Uniform Reports of Locomotive Performances—Authorized Standard Forms. George W. Cushing (Suggestions as to the form in which to make a locomotive report so that it can be compared intelligently with that of other locomotives). Loc Engng–March. 1200 w.

*4647. British Locomotive Designers are Slow (Criticism of points in design). Loc Engng–March. 800 w.

4651. The Sand Track. Robert Grimshaw (The discussion of methods which make a locomotive or car leaving the track as a safety measure, a safe thing to do. The article has some interesting data). Sci Am Sup–March 7. 1800 w.

4665. The Development of the Freight Car Door (An interesting communication, concluding with the features considered essential in a perfect car door). Ry Mas Mech–March. 2700 w.

4666. Standard Loading of Lumber and Timber. Pulaski Leeds (Rules for loading on freight cars lumber up to 100 ft. long. The directions are full and explicit). Ry Mas Mech–March. 500 w.

4667. Locomotive Grates for Anthracite Coal (Circular of inquiry issued by a committee of the Mas. Mech. Assn. which shows very plainly the points in practice which at present are demanding the attention of designers and operators of locomotives). Ry Mas Mech–March. 1800 w.

*4687. The New Caledonian Express-Engine Dunalastair. Charles Rous-Martin (A good example of a modern English engine. The center of boiler is 8-ft. above rails; the driving wheels are 6½-ft. diameter; weight of engine and tender is 87 tons; and a new feature is a very commodious cab, which is an innovation in England). Eng, Lond–Feb. 28. 2500 w.

*4693. Narrow-Gauge Light Railway; Caen to Dives and Luc sur-Mer (This 2-ft. gauge track in Normandy is equipped with 30 lb. rails, built at a cost of 2143l. per mile, exclusive of cost of land. The description includes six views from photographs). Engng–Feb. 28. 1300 w.

*4706. Intercommunication in Railway Trains. J. Pigg (Illustrated description of device intended for use on English railways). Elec Eng, Lond–Feb. 28. 2000 w.

*4709. Observations of English Railway Practice, with Some Account of the Fifth Session of the International Railway Congress. George B. Leighton (Read before the club. Jan. 8, 1896). Jour Assn of Engng Soc–Jan. 7000 w.

*4713. The Light Railways Bill (The bill is now presented to Parliament and will probably pass. The editor's remarks upon it are interesting as they reflect the sentiment and opinion of many). Trans-Feb. 28. 2000 w.

4718. Proposed Electric Railways in Colorado. J. W. Dickerson (Illustrated description of proposed road of the South Platte Railway and Power Co. intended to connect Denver with Cripple Creek. The current for the operation of the line is to be generated by water power at different points along the route). Elec Ry Gaz–March 7. 2000 w.

†4726. The Bursting of Air-Brake Hose. A. M. Waitt (Extracts from paper read before the Western Railway Club (Chicago). The result of careful examination of burst and worn out hose, with the writer's suggestions for remedying troubles arising from the same, and much general information). Ind Rub Wld-March 10. 2700 w.

SCIENTIFIC MISCELLANY

How to Look up References in Physics.

Few who have not had experience in looking up topical references have the slightest idea of the labor involved in such a research. All such as have not devised a system of their own, and many who have, will be thankful for the assistance afforded by Mr. Edward L. Nichols, whose remarks upon the subject, as related to the literature of physics, made in the Physics Seminary of Cornell University January 28, are presented in the form of an abstract in *The Sibley Journal of Engineering* for February.

The first pointer given is that by far the larger mass of valuable records in physical science is to be looked for in the present century. Back of this, extending through medieval times to the Greek school in Alexandria, are to be found older sources of knowledge, and the best guide to research in these is named as "Fischer's History of Physics (eight volumes), published in Göttingen." The eighth volume of this treatise contains an alphabetical list of authors, but no index of subjects. "Gehler's Dictionary," Leipzig, 1825 (new editions by Brandes, Gmelin, and others), and "Kopp's History of Chemistry," are named as good helps.

It is also easier to look up a subject where writers' names are known than from topics alone, for the simple reason that the classification of scientific papers under the author's name is a much less complicated matter than the arrangement of them by topics. The latter, indeed, is well-nigh impossible. The names of one or two writers on a topic the literature of which is to be looked up are almost always known, and these names serve as a key. The first step is to find where the papers of these known authors were published. For this purpose certain lists are to be consulted. In English we have the catalogue of scientific papers published by the Royal Society of London, 1867. This list goes back to the beginning of the present century, and is international in its scope. It covers the entire domain of science, and is, therefore, necessarily very voluminous. The original catalogue goes up to the year 1863, since which time two supplements have appeared; the first covers the whole alphabet to 1873, and the second, for the decade 1873-83, is now in preparation, and has already appeared up to the letter P.

This is the only complete author's list in the English language. In Germany, a similar book, dealing, however, chiefly with physics and allied subjects, and much more compact in form, is the "Biographical Dictionary" of Poggendorf, Leipsic, 1863,—a dictionary of scientific authors, containing a fairly complete list of titles under each name up to about 1860. This work gives also titles of the work of the very earliest physicists with brief biographical data. In 1877 the publishers of the great German journal of physics, the *Annals of Physics and Chemistry*, began the publication of the "Beiblatter," a journal in which the literature of physics of all countries is abstracted by a committee of eminent physicists under the direction of Prof. E. Weidemann. This periodical gives monthly summaries. At the end of each volume is a list of authors, and at the beginning a classified, but not alphabetical, list of papers. This is the best series for the period covered. A similar task has been recently undertaken by the Physical Society of London, with a view to forming in English a summary of the literature of physics. Systematic reviews of current electrical literature have likewise been regularly published by some of the technical journals. Such are the "Engineering Index" published in The Engineering Magazine, and the synopses published by Carl Hering in *Electrical World*, and by Max Osterberg in *Electric Power*. The French *Journal de Physique* has published a series of abstracts, but they do not cover the ground exhaustively. "Index volumes of scientific periodicals afford the principal sources of information concerning the whereabouts of scientific papers. Especially serviceable are *The Philosophical Journal*, established 1798; *American Journal of Science*, established 1819; *Annales de Chimie et de Physique;* and *Annalen der Physik und der Chemie.*

"In 1888 the last-named journal published a register of the subjects contained in the entire Poggendorf series. This series covered the period from 1824 to 1877, during which Professor Poggendorf, the author of the 'Biographical Dictionary,' already mentioned, was editor of the *Annalen*. There is also an index of names from the *Annalen*, covering nearly the same period. The issues of this journal cover pretty nearly the entire period of modern scientific activity."

Of more modern journals the following are named: "*The Physical Review*, the *Astrophysical Journal*, and *Science*, in America; the *Journal de Physique*, in France; *Nature*, in England; the *Repertorium der Physik*, *Zeitschrift für Instrumentenkunde*, etc., in Germany; the *Nuovo Cimento*, etc., in Italy, to say nothing of the host of technical journals dealing with the various branches of engineering and with manufacturing interests."

Some of the peculiarities of these journals which are puzzling to those unaware of them, are named. Of these one of the journals that presents the most perplexing complications is *Poggendorf's Annalen*, which, since the death of Poggendorf, has been published as *Wiedemann's Annalen*. Much confusion exists in the numbering of the volumes. "Bookbinders are naturally thrown into confusion by these complications, and it is a matter of the greatest uncertainty as to which of the numbers will appear on the back. The set in the library of Cornell University, for example, is numbered by the binder with numbers which differ by sixty-eight from the number which one seeks, when counting from the beginning of the Poggendorf series." Similar complications arise in the cases of the *Annales de Chimie et de Physique*, the *Philosophical Magazine*, and the *American Journal of Science;* although the illustration just cited affords perhaps the most perplexing example. The transactions and proceedings of the Royal Society of London and the French Academy of Sciences are the most important aids to research. The *Philosophical Transactions* is a quarto publication running back to 1865, and the *Proceedings* are in octavo volumes, covering the period from the year 1800 to date. The French Academy publishes two sets, —the *Comptes Rendus*, from 1835 to date, and the *Memoires*, commenced in 1816.

Although the publications of the two societies named rank first in importance, there are numerous other scientific societies which are doing good work, and issuing valuable publications. An admirable classification and summary of these publications is *Wiedemann's Beiblatter*.

"Another useful periodical is the *Summary of Technical Literature*, founded in 1856, under the editorship of Schubarth in 1856, and giving titles as far back as 1824. The literature from 1856 on was worked up by Kerl, who was followed by Biedermann and later by Rieth, the present editor. The *Fortschritte der Electrotechnik* and the *Fortschritte der Physik* belong to the same class. The last named for many years lagged so much behind the times as to be of comparatively little value. It has, however, been recently taken in hand by the Physical Society of Berlin, and brought nearly up to date.

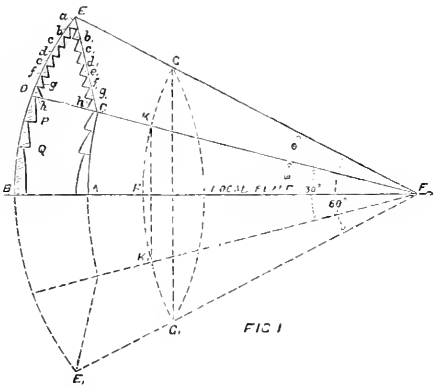
"Still another excellent source of information for the searcher in scientific bibliography is the volume of tables published by Landolt and Bernstein, Berlin, 1894. These tables afford not only the most trustworthy and valuable data concerning nearly all the constants of nature, but likewise references to the sources whence these data have been obtained. Under the headings given in this volume, which includes nearly everything which can be a subject of research in the domain of physics, we find an alphabetical list of the authors from which the lists have been taken. Nowhere else can one find in such compact form the list of the chief observers in any branch of physics."

This article will prove helpful to all technical readers.

New Form of Lighthouse Refractor.

THE latest advance in lighthouse appliances is described in *The Engineer* (Dec. 20). The following is an abstract of a description of the invention given in an article written by Mr. John A. Purves, B. Sc.

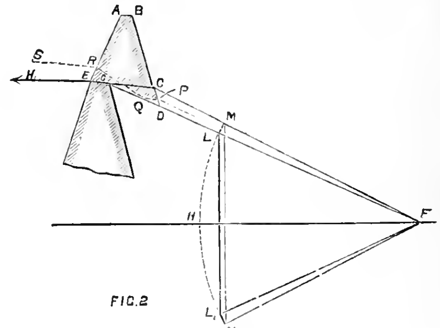
The essential and novel feature of this apparatus consists in the inversion of the facets of the lens elements, so that these, instead of projecting outwards, are made to project inwards, thus leaving the out-



side face quite smooth. This arrangement with any form of prism but the equiangular—the invention of Mr. Charles A. Stevenson—would entail a loss at each arris, which above fifteen degrees from the focal plane would be very considerable. With the equiangular form of prism this loss is inappreciable up to fifteen degrees, and, as will be shown, is far more than compensated by the great gain produced in the increase of focal length, even when the inverse refractor is carried to a total height above and below the focal plane of thirty degrees, thus subtending a total vertical angle of sixty degrees. The new form of refractor, being approximately spherical, possesses all the advantages of the truly spherical refractor, while at the same time it has none of its disadvantages arising from abnormal divergences above 20 degrees, since the use of the equiangular prism produces the minimum amount of divergence possible over the whole refractor.

By using this form of refractor the same power of light can be obtained from a smaller apparatus, thus reducing the actual cost, enabling smaller lanterns to be used, and reducing the weight of the revolving apparatus,—an important consideration, as quick-flashing lights are so much employed.

The inverse lens has also the merit of utilizing to the fullest advantage the best part of the light,—namely, that immediately above and below the focal plane. Being practically spherical in form on the outside, the external gun-metal setting can be of the simplest, while internal ones might almost be dispensed with, as it is impossible for the rings of this apparatus to fall inward. The simplification of settings not only does away with loss of light, but reduces the weight of apparatus. Having briefly noted the points where the new and old forms of refractors differ, it now remains to be shown what the actual gain in power of the new inverse lens is. The plan adopted is that of a comparison of two hyper-radiant apparatuses, refractors only, the one which is compared with the new lens being of the most approved type,—namely, with spherical center and equiangular concentric rings of



prisms completing the refractor. In comparing the new form of refractor, *B D E*, with the old composite form, such as *A C E*, in which *A C* is of spherical sections, the rest of the refractor, *C E*, being composed of equiangular prisms, it is necessary to take note of the following points: (1) both lenses subtend the same vertical angle,—Fig. 1, equal to sixty degrees; (2) in the case of the new lens, *B D E*, where the facets are turned inwards, we have a loss of light at each arris. This loss is most easily computed when we consider the area of the illuminated portion of a sphere, of radius, $F H$, subtended by the cone whose angle is $G F G$, in comparison with the same surface of sphere minus the zones of partial darkness produced by the loss at the arrises.

To explain the loss at the arrises suffered in the new refractor we may refer to Fig. 2. In this figure, let $A B C D E$ be one of a series of the inverted equiangular prisms; F the focus of the apparatus. Now, the focal ray, $F C$, after striking the glass at C, follows the course, $C E$, and then emerges finally in the horizontal direction, $E H$. Now, the next ray from the focus which will be truly parallelized is $F D$, which, falling upon G, so deals with the top point of the prism below $A B C D$ as to cause it to emerge in the horizontal direction. It is now seen that the angle, $C F D$, represents so much loss, as any light within it is not truly parallelized. But, by bringing the face, $B C$, of the prism to D, this loss is reduced, for a ray falling upon such a point as P is refracted to Q, reflected from Q to R, and finally refracted again from R in a direction approaching the horizontal. We have, however, considered the loss sustained as being total, and we have calculated it as follows: the portion of the sphere whose radius is $F H$, and whose angle of cone in the apparatus considered is sixty degrees, will be reduced in the case of the new lens by zones of darkness upon it represented by $L M L M$.

A calculation shows that the total net gain of the new lens, over the old ones of same size and most approved form, is approximately 15.4 per cent.

Röntgen's Shadowgraphs.

THE following explanation of Röntgen's discovery, at present the most attractive subject of scientific study, is so clear and explicit that we do not hesitate to call it the best popular explanation which has yet appeared. It was received from a special correspondent of *American Journal of Photography*, and printed in the February number of that journal.

"For a considerable time past various physicists have been of the opinion that the oscillatory motion of vibration of light was not only transverse, but longitudinal as well. This theory was confined chiefly to such light rays as were absolutely invisible to the eye, and entering upon the ultra-violet. In the daily papers communications have appeared at various times regarding these vibrations, among the latest being the highly-colored accounts of the experiments by the Wurzburg Professor Röntgen. It is here stated that Professor Röntgen succeeded in obtaining photographs, by aid of these invisible rays, without the use of any photographic apparatus. This statement, impossible as it may appear at the first glance, may be explained by the following statement of facts.

"If an induction current is passed through a Geissler tube filled with rarefied air, there appears upon the negative electrode a thin seam of light surrounded by a relatively dark, bluish glow of light. The surroundings of the positive electrode, on the contrary, and the larger part of the enclosed space, are filled with strata of bright, red-yellow light. This phenomenon changes perceptibly when the rarefaction of the air within the Geissler tube is increased. When a certain degree of rarefication of the air is reached, the blue glow-light expands, and, under certain conditions, fills the whole interior of the tube. When this is the case, the glow-light causes a fluorescence wherever it strikes the glass.

"This phenomenon was studied and published by Hittorf so far back as 1889. Subsequently other scientists beside Hittorf and Crookes occupied themselves with the study of this phenomenon. Prominent among the latter were such authorities as Reitlinger, E. Goldstein, Gintl, Pubeg, Voller, Zoch; and the conclusion was reached that these cathodic rays were endowed with a series of peculiar properties. The most curious of these qualities is that the cathodic rays spread themselves (grad–linig), and not as those of the induction current, which turn corners and follow all the turnings and twistings of the tube. This peculiarity of the cathodic rays was not discovered by Röntgen, but has been known in scientific circles since the publication of Hittorf and Crookes. The former, as well as the latter, gave very explicit instructions for experiments which would show the chief properties of the cathodic rays. Probably the best account is to be found in the well-known text-book of Muller-Pouillet.

"Even the peculiarity of the cathodic rays, to show a unique shadow-structure, and which now forms the leading wonder in Röntgen's experiments, has long been known, and attention had been called to it. Now Professor Röntgen has substantiated the fact that the cathodic rays were not undulatory, but extended in straight lines, and were able to penetrate almost all solid bodies, metallic, of course, to a less degree than wood, etc. Röntgen covered with a roll of thick black card-board a Geissler tube in which cathodic rays could be produced. Notwithstanding that no rays of light whatever could escape, he noticed in the completely-darkened room that a screen with luminous paint, which was on line with the covered tube, became luminous or phosphorescent. The action of the light was noticeable on the paint up to a distance of two meters from the apparatus. When any solid objects were placed between the screen and the covered tube, it was noticed that almost all substances were penetrated more or less by the cathodic rays. A pine board an inch thick had no more effect in obstructing the rays which Röntgen temporarily designates as X rays than several thicknesses of hard rubber plates. Metals, on the contrary, even in thin sheets, exercised a more or less weakening effect upon the rays. All of the super-imposed solids threw a more or less dense shadow or penumbra upon the luminous screen.

"As an example, when the hand was held between the tube and luminous screen, a shadow is created in which the bones of the hand are distinguishable by a much deeper shadow than that formed by the more transparent substances. One great advantage, thanks to modern photographic methods, is that these shadow pictures can be made permanent by simply substituting for the luminous screen a sensitive plate, film or paper, which, after exposure, can then be developed and fixed in the usual manner: these results, however, are by no means a photograph in the accepted sense, but merely a shadowgraph or silhouette, which, under the best conditions, may consist of a penumbral shadow, showing different degrees of density."

Scientific Kite-Flying.

THIS title to a most interesting article by Mr. Cleveland Moffett in *McClure's Magazine* for March might also have been made to read "Utilitarian Kite-Flying," since its perusal will convince any one that kite-flying can minister to numerous and useful ends. People have been so wont to regard kites as mere toys, and kite-flying as a mere amusement, that, although the great Franklin made it serve a useful scientific purpose in his famous experiment with kite and key in drawing electricity from the clouds, few have really ever seen the real possibilities of kites as factors in human progress.

An article by Professor J. Woodbridge Davis, page 213, vol. 7, of *The Engineering Magazine*, entitled "The Kite as a Life-Saver at Sea," describes a mode of rendering kites dirigible and of great strength in flight, invented by the author of that interesting paper.

Some of the experiments therein described are, indeed, remarkable. Mr. Moffett's paper sets forth other uses to which kites can be put. First, he gives plain deductions for making tailless kites, these being preferable for most of the purposes named, and also gives directions for manipulating kites, which show that perfection in the art of making flying kites is to be reached only by patient aspirants. But, when sufficient skill is attained, the kite may become an important appliance in the study of atmospheric phenomena; in fact, by its aid important contributions to meteorological science have been made already.

Another useful purpose is the taking of bird's-eye photographs. Several examples of views taken from high altitudes by means of kites, by Mr. Eddy of Bayonne, N.J. (yclept by Mr. Moffett the "king of kite-flyers"), illustrate the article under review, and demonstrate the practicability of the kite as an aid to photography. These views show that in military engineering, and perhaps in other branches of engineering, the kite can now take rank among scientific appliances for surveying. The apparatus employed for taking photographs from high altitudes is described as follows:

"A wooden frame capable of holding the camera has attached to it a long stick or boom, by means of which the camera is made to point in any desired direction or at angle. This is arranged before sending up the apparatus, the boom being properly placed and held in position by means of guy cords from the main kite-line. A separate line hanging from the spring of the camera shutter, with which is also connected a hollow ball of polished metal supported in such a way that it will drop from its position, five or six feet through the air, when the camera cord is pulled. The purpose of this ball is to allow the operator on the ground to be sure that the camera has responded to his pull, and that the desired photograph has been taken. He is assured of this, having given the pull, on seeing the flash made by the polished ball in its fall.

"All this being arranged, it is only necessary to send the camera up to any desired altitude and pull the camera cord, in order to get photographs of wide-stretching landscapes, extensive cities, like New York, and panoramas of every description. Such photographs could not but be of the greatest value to geologists, mountain-climbers, surveyors, and explorers. And they must possess particular interest for students of geography and for map-makers."

The application to military *reconnoissance* is obvious, and the greater convenience of the kite, as compared with captive balloons hitherto employed for this purpose, is also recognized.

"Mr. Eddy regards it as perfectly possible to send up a tandem of kites from the deck of a man-of-war, with a circular camera, such as has already been devised, attached to the main line, and an apparatus for snapping all the shutters simultaneously; and photograph, not only the whole horizon as seen from the deck of a vessel, but, because of the greater elevation, many miles beyond. A battle-ship provided with this photographic device would enjoy as great advantage as if it were able at will to stretch out its mainmast into a tower of observation a mile high.

"It is true that some of the lenses in the circular camera—the ones facing the sun—might give imperfect pictures, but, in whatever position the sun might be, at least one hundred and eighty degrees of the horizon would be clearly photographed. And, by taking such observations in the early morning, and again in the middle of the afternoon, it would be possible to cover the whole circuit, and thus be aware of the approach of an enemy's ships long before they would have been visible to a telescope used on the deck. In such a circular camera each lens would be numbered, and the position of each would be accurately determined with regard to the points of the compass by the use of guy-cords stretching from the main line to the framework of the apparatus. Thus, on looking at the number of a lens, the photographer would immediately know the vessel photographed."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Scientific and Engineering Journals—See Introductory.

*4089. Prof. Röntgen's Discovery in Photography. Ill. Michael I. Pupin (Its scientific character and possible application throughout all branches of science, as indicated by Mr. Pupin's re-performance at Columbia College laboratory of Prof. Röntgen's extended experiments). Eng Mag-March. 1896. 2000 w.

*4120. The New "Rays." Sydney F. Walker (A letter to the editor calling attention to the fact that the writer contributed, about three years ago, his views relating to electricity, magnetism, etc., which are confirmed by Röntgen's experiments; with explanation of his reasons for his views). Elec Eng, Lond-Jan. 31. 1500 w.

*4121. On the Rays of Lenard and Röntgen. Oliver Lodge (A review of the events and experiments in this field, with a consideration of the facts established and views entertained). Elect'n –Jan. 31. 4000 w.

*4122. Prof. Röntgen's Epoch-Making Discovery (The closing remarks of a paper in the *Zeitschrift für Elektrotechnik*, by Prof. Boltzmann, supporting the idea that the explanation of the rays lies in the longitudinal vibrations in the ether. Also editorial). Elect'n–Jan. 31. 1700 w.

4128. Roentgen's Shadowgraphs. R. H. Read (Describes a test by an English experimenter). Elec Rev–Feb. 12. 500 w.

4129. "X Ray" Photography. H. G. T. (A chat with Prof. A. E. Dolbear on this subject. His experiment in 1892, and a few points wherein he differs with Prof. Roentgen). Elec Rev–Feb. 12. 1300 w.

4132. Cathodographic Experiments. Elihu Thomson (Illustrated suggestions for the purpose of assisting experimentation in this field). Elec Eng-Feb. 12. 1200 w.

4133. Mr. Edison's Experiments with X-Rays (Illustrated account of work done by Mr. Edison in this field). Elec Eng–Feb. 12. 1300 w.

4136. Röntgen Rays (A brief summary of the experiments and investigations in this country during the week ending Feb. 15, with editorial . Elec Wld–Feb. 15. 2300 w.

4140. A Few Remarks on Experiments with Roentgen Rays. M. I. Pupin, with editorial (Illustrated account of further experiments by the writer, with observations of general interest). Elec–Feb. 12. 2300 w.

4173. The Gobelins Tapestry Manufacture. Robert Grimshaw (Interesting history of a great art industry. Illustrations of noted works by the Gobelins). Sci Am Sup–Feb. 15. 2800 w.

4176. Roentgen or X-Ray Photography (Illustrated description of experiments of Prof. Wright, at Yale). Sci Am–Feb. 15. 1800 w.

4178. William Crookes. Ill. (Sketch of his life and his remarkable discoveries, and contributions to scientific literature). Sci Am–Feb. 15. 900 w.

4191. Photographic Experiments in Chicago with Röntgen Rays. Frank L. Perry (Illustrated description of experiments made). W Elec–Feb. 15. 1600 w.

4192. Experiments on the X–Rays (An account by Edwin B. Frost of Experiments made at the Dartmouth physical laboratory. Also an account by Arthur W. Goodspeed of experiments made in the physical laboratory of the University of Pennsylvania). Science–Feb. 14. 1000 w.

*4196. The X–Rays (Editorial review of investigations made to determine the nature of these rays). Elec Rev, Lond–Feb. 7. 1200 w.

*4200. Röntgen's Radiations (Editorial on the progress made during the last two weeks, in ascertaining the properties of these new radiations). Elec Eng, Lond–Feb. 7. 700 w.

*4238. The Chimney Disaster at Burnley. Ill. (The conditions precedent and the immediate causes of the collapse of this great chimney are described. Incidentally some reference is made to other similar catastrophes, fortunately of rare occurrence. The evidence before the coroner's jury is the basis of the paper). Eng, Lond–Feb. 7. 4000 w.

†4239. The Utilization of Waste Steam. From *The Paper Makers' Circular* (Treats of the utilization of waste steam in manufacturing, more particularly in paper-making). Ind & East Eng–Jan. 18. 1400 w.

†4240. Humidifiers and Ventilators (Illustrated description of a new apparatus for regulating the hygrometric condition of the atmosphere of manufacturing establishments, more particularly those producing textile fabrics, whereby much more uniform results are attainable than heretofore). Ind & East Eng–Jan. 18. 800 w.

*4266. On the Present Hypotheses Concerning the Nature of Röntgen's Rays. Oliver Lodge (An examination of hypotheses advanced thus far in the study of these rays, with the conclusion that no satisfactory proof has yet been reached). Elect'n–Feb. 7. 3800 w.

4271. Photographing Hidden Objects by the Arc Light. J. Hart Robertson (Description of an experiment made by the writer). Elec Eng–Feb. 19. 700 w.

4272. Cathodographs by the Discharge of Leyden Jars and Other Disruptive Discharges of Static Electricity. Ill. William James Morton (An experiment which demonstrates that cathodography can be accomplished simply by the aid of charged Leyden jars alone). Elec Eng–Feb. 19. 800 w.

4273. On Radiant Matter. William Crookes (A lecture delivered before the British Assn. for the Advancement of Science, Aug. 22, 1879, and of special interest now, because of the re cent discoveries). Elec Eng–Feb. 19. 1800 w.

4274. The Week's Progress in Shadow Photography (A review of work by various scientists during the past week). Elec Eng–Feb. 19. 700 w.

*4290. Catenary Problems. G. M. Minchin (Graphic methods for solving problems in catenary curves involving, by the mathematical method, the use of transcendental equations). Engng–Feb. 7. Serial. 1st part. 2500 w.

4299. Incandescent Gas Lighting for Photographers (Extract from paper read before the Croydon Camera Club by Mr. John A. Hodges, reprinted from the *Gas Engineers' Mag.* Discusses advantages of the incandescent gas light to photographers, and methods of applying it). Pro Age–Feb. 15. 1900 w.

4310. Röntgen Rays (A review of work done by different scientists during the past week or two, with editorial). Elec Wld–Feb. 22. 2000 w.

4312. Röntgen Rays With Statical Machines. Ill. M. I. Pupin (Experiments made with the object of ascertaining whether satisfactory results could be obtained by the employment of the Holtz machine. The results were quite satisfactory and some interesting facts relating to time of exposure, effect, etc., were determined). Elec–Feb. 19. 800 w.

4313. Communications From William J.

Morton and M. I. Pupin (A controversy, with editorial). Elec–Feb. 19. 2800 w.

4316. The Manufacture of Tacks (Sketchy, illustrated description of machines and processes). Sci Am–Feb. 22. 700 w.

4320. Chemistry as a General Education. Peter T. Austen (A paper read before the Students' Chem. Soc. of the Polytechnic Inst. on the usefulness of the profession of chemistry in the arts, and general effects of the study as an educational pursuit). Sci Am Sup–Feb. 22. 5200 w.

*4352. Professor Röntgen's Miraculous Photographs Explained. Julius F. Sachse (One of the clearest and most explicit popular explanations of Professor Röntgen's discovery that has yet appeared). Am Jour of Photo–Feb. 1000 w.

*4370. Technical Institutes. Sidney H. Wells (A paper read before the Arch. Assn., England. General remarks. The requirements are divided for convenience in treatment into (1) educational, (2) administrative, (3) recreative and social, (4) general). Arch, Lond–Feb. 14. Serial. 1st part. 6000 w.

4403. The New Photography. W. M. Stine (A review of the ideas advanced regarding this new discovery, with some views of the writer). W Elec–Feb. 22. 1900 w.

*4410. New Properties of the Cathode Rays. Jean Perrin (Translated from *Comptes Rendus*. An account of experiments made by the writer for the purpose of investigation). Elect'n–Feb. 14. 900 w.

*4430. How to Look Up References in Physics. Edward L. Nichols (Abstract of some remarks made in the Physics Seminary of Cornell University. An admirable guide to those who wish to explore the literature of physics with reference to any particular subject or topic. Within what dates, how to look, where to look, and what to look for are very clearly presented, thus outlining a systematic investigation which in its nature will be thorough instead of discursive). Sib Jour of Engng.–Feb. 2000 w.

4431. Röntgen Rays (A review, with abstracts of articles written by men of eminence in scientific investigations, which have recently appeared in various periodicals. Illustrations of some of the experiments are given). Elec Wld–Feb. 29. 2400 w.

4452. Photography with Invisible Radiations (Editorial on the importance of a correct knowledge of the new phenomena, and the value of investigations). Elec–Feb. 26. 1000 w.

4463. Scientific Kite-Flying. Cleveland Moffett (An interesting account of the work of Mr. Eddy, of Bayonne, N. J., treating of how to make a scientific kite; how to send up a kite; runaway tandems; the meteorological use of kites; the highest flight ever made by a kite; drawing down electricity by a kite string; the use of kites in photography, the possible use of kites in war, etc. Also reproductions of photographs taken from a kite and other pictures). McClure's Mag–March. 8000 w.

*4470. Fruit Culture in the Himalayas (It appears that a great variety of fruits flourish in this region; among those named are apples, pears, peaches, plums, and cherries. The conclusion is that Himalayan fruit culture can be made a lucrative business, with some outlay of capital and with scientific culture). Bd of Tr Jour–Feb. 900 w.

4491. Experiments with the X-Rays at Armour Institute Laboratories. W. M. Stine (A summary of the experiments, with results). W Elec–Feb. 29. 2800 w.

4494.—$1. New Academic Degrees at Paris. C. W. A. Veditz (Discusses recent changes and proposals for reorganization in the French universities, of interest to American students contemplating foreign study). An Am Acad–March. 1700 w.

*4499. The Nicaragua Canal an Impracticable Scheme. Joseph Nimmo, Jr. (The author declares from results of his own compilation that the amount of tonnage that has been estimated would pass through an American interoceanic ship-canal has been greatly exaggerated. Upon this and other considerations he concludes that the scheme of a Nicaragua canal is impracticable, and he charges that from the beginning, its promoters and advocates have studiously avoided anything like a thorough discussion of the economic and commercial conditions which determine the question of practicability), Forum–March. 6000 w.

†4502. Jamaica as a Field for Investment. Henry A. Blake (An interesting description of the natural resources and commercial opportunities of this island, in which the climate is healthy, the soil fertile, and in which it is predicted the unthrifty methods that have hitherto prevailed are soon to be replaced by systematic cultivation, and increased facilities for transit). N Am Rev–March. 2000 w.

*4505. The Production of Iron. Ill. (A description of ancient methods, including its early history in England). Mach, Lond–Feb. 15. 1700 w.

†4511. Steppes, Deserts, and Alkali Lands. E. W. Hilgard (An explanation is herein attempted, of the singular fact that the countries which have harbored most of the ancient civilizations are regions of deficient rainfall and compulsory irrigation; and an examination of the effect of deficient rainfall upon the character of soils in arid regions). Pop Sci M–March. 4800 w.

†4537. Sumatra Tobacco (Particulars of the development of Sumatra tobacco planting obtained from the Consul-general of the Netherlands). Cons Rept–March. 1700 w.

*4540. Experiments with Soaring Machines. Ill. Percy S. Pilcher (A letter objecting to a statement made regarding his success, and giving some account of his experiments). Nature–Feb. 20. 1000 w.

*4541. The Röntgen Rays (A summary of the more important results obtained since the publication of Prof. Röntgen's paper). Nature–Feb. 20. 4800 w.

*4557. Professor Dewar's Apparatus for Liquefying Air and Oxygen (Illustrated description of an apparatus whereby a temperature of —180° C. is obtained in from 25 to 30 minutes). Engng–Feb. 21. 200 w.

†4580. A Ferruginized Tree. Oscar C. S. Carter (Description of a tree found in Montgomery Co., Pa., that has been ferruginized or pseudomorphosed into iron ore. The geological and mineralogical environment shows a curious relation to this rare phenomenon). Jour Fr Inst-March. 800 w.

*4585. On the Production of Electric Phenomena by Means of Roentgen's Rays. Auguste Righi (From the Proceedings of the R. Accademia delle Scienze dell' Instituto di Bologna). Elect'n-Feb. 21. 1800 w.

*4587. Röntgen Rays and Their Source. Ill. T. H. Muras (A few particulars of some experiments with ordinary apparatus). Elec Rev, Lond-Feb. 21. 1300 w.

*4588. On the Rays of Röntgen. E. Salvioni (A communication made to the Medico-Chirurgical Academy of Perugia. Results of some studies undertaken by the writer). Elec Rev, Lond-Feb. 21. 800 w.

4592. The Importance of Water in Plant Production. Thomas F. Hunt (The writer considers the water supply the most important factor in farming and gardening operations). Brick-March. 6000 w.

4595. Farm Drainage. John Cownie (Some consideration of the importance of drainage and irrigation, and recommending the securing of legislation to aid the farmer in draining his land). Brick-March. 3300 w.

4596. Drainage Laws. Joseph A. Williams (The law of drainage in the state of Iowa is discussed). Brick-March. 4000 w.

4597. Measurements of High Temperatures for Clay-Workers. Edward Orton, Jr. (The known ways of measuring heat are classified and briefly considered, and the Seger cone and its advantages are presented). Brick-March. 4400 w.

4599. Light Rays Which, in Their Penetrating Power, Resemble Roentgen's X-Rays. N. D. C. Hodges (The purpose of this note is to call attention to the properties in common of certain radiations which, while somewhat unusual in character, have been classed hitherto as light rays not essentially peculiar in their method of propagation, with those radiations which are now known as Röntgen's X-rays). Elec Eng-March 4. 500 w.

*4608. Experiments Upon the Cathode Rays and Their Effects. Arthur W. Wright (Illustrated description of experiments performed at Sloane Physical Laboratory, of Yale University, and suggestions derived from a consideration of the circumstances under which the different shadowgraphs were produced). Am Jour of Sci-March. 4200 w.

†4609. Triangulation by Means of the Cathode Photography. John Trowbridge (Describes an attempt to apply the principles of triangulation to indicate more exactly the position of concealed bodies whose presence is revealed by Röntgen's method). Am Jour of Sci-March. 800 w.

†4610. Notes of Observations on the Röntgen Rays. Henry A. Rowland, N. R. Carmichael, and L. J. Briggs (These observers assert that in a tube with aluminum poles they have determined that the main source of the rays is a minute point on the anode nearest the cathode, and that the whole of the anode gives out a few rays. In this tube the cathode gave out no rays). Am Jour of Sci-March. 600 w.

4627. Röntgen Radiographs. Ill. (Engravings of radiographs made by Mr. Herbert B. Shallenberger, are explained and the experiments described). Elec Wld-March 7. 800 w.

4631. The Röntgen Rays. D W. Hering (General remarks). Elec Wld-March 7. 1600 w.

4653. Apparatus for Copying and Enlarging by Photography. A. P. Wire (Comprehensive description and explanation of processes and apparatus required, with numerous diagrams). Sci Am Sup-March 7. 2500 w.

4668. Application of the X-Rays to Surgery. Henry W. Cattell (A brief consideration of what has already been accomplished in this direction, with an enumeration of a few achievements we may expect). Science-March 6. 1000 w.

4671. Further Experiments with Röntgen Rays. W. M. Stine (Descriptive). W Elec-March 7. 1200 w.

4672. Application of X-Rays for Exhibiting Invisible Objects in Motion. Edward P. Thompson (Experiments described). W Elec-March 7. 700 w.

4673. Röntgen Photography. H. S. Carhart (Observations on experiments made by writer). W Elec-March 7. 400 w.

4674. Sciagraphs and Electrographs. W. M. Stine (Illustrations and descriptions of supposed sciagraphs, investigated with the view of discriminating between true and spurious sciagraphs). W. Elec-March 7. 1500 w.

*4684. The Palette of the Potter. William Burton (Processes, colors, and methods employed in pottery painting, and the effect of firing upon colors so used. Contains valuable information upon the subject. Discussion). Jour Soc of Arts-Feb. 28. 13000 w.

*4712. Photography of Invisible Objects. Ill. J. J. Stewart (A short statement of the facts discovered and the methods of experimenting employed by Prof. Röntgen). Knowledge-March 2. 1500 w.

*4722. The Röntgen Rays. J. J. Thomson (An account of investigations made to determine the nature of these rays). Nature-Feb. 27. 1500 w.

†4727. The Use of Gutta-Percha in the United States. John M. Armstrong (The history of gutta-percha, its discovery, uses, etc., and its importance. Comparison is made with India-rubber, showing the radical difference between the two gums). Ind Rub Wld-March 10. 2500 w.

†4728. A Traveling Man on Brands. F. C. Anderson (Dealing with brands on rubber goods, but equally applicable to other products). Ind Rub Wld-March 10. 500 w.

THE

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THE PRESENT VALUE AND PURCHASING POWER OF GOLD.

By H. M. Chance.

THE value of gold is fixed in the long run by the cost of production. At the present time its value—*i. e.*, its purchasing power—is abnormally above the cost of production, having increased steadily for twenty years, although within the last five years the cost of producing it has rapidly declined. The tendency, daily becoming more apparent, to accept gold mining as an industry more promising of profits than other enterprises is, therefore, in harmony with existing conditions.

The price of no product subject to the influence of competition can remain permanently lower than the cost of production, for men will refuse to produce it for such price; and, conversely, the price of such product can not be maintained at more than a fair margin over the cost of production, because many are always willing to produce and sell any product at the lower price.

We may, therefore, safely conclude that the value of metals, as of other products, is fixed by the cost of production, and that all permanent changes in value arise from increase or decrease in the cost of production. Some metals, and other products, manufactured by secret or patented processes, and some natural products known to exist over comparatively small areas which are controlled through combinations of the owners or by the sole ownership of an individual or corporation, are exempt from the influence of competition, which reaches only those products the production of which is open to all, and the output of which is limited only by the labor available for their production.

The production of few metals is artificially controlled. Aluminum and sodium, interesting examples, because of the abundance of the materials from which they may be extracted, have been made by patented reducing processes, and their prices thereby maintained at an artificial level.

Some of the rarer metals, of which bismuth and mercury may be taken as types, have been kept at higher prices than might obtain were production unfettered, control of the principal sources of supply having become vested in a few owners. Diamond mining may be noted as belonging to this class of industries.

Attempts to regulate the output and price of metals more largely used and more widely distributed have always failed, usually with results disastrous to the originators.

As the production of iron, lead, zinc, tin, copper, silver, and gold is unrestricted, and as their ores are widely distributed and not controlled by closely allied owners, an inquiry into their values involves merely a review of those factors affecting the cost of production as the sole and final measure of value.

The decline in the value of silver from $1.20 per ounce in 1876 to 67 cents per ounce in 1896 was possibly precipitated by legislation, but was inevitable, because the cost of producing it had declined.

As the market value of other metals suffered a like decline during the same period, the change in values is often attributed to enhanced value of gold; but, as a general decline in the cost of producing all metals was effected in the same period, and as the cost of producing gold cannot be assumed to have increased, the enhanced purchasing power of gold is merely an expression of the decline of other values.

Within this twenty-year period iron has fallen from $22.50 to $12.00 per ton, lead from 6 cents to 3¼ cents per pound, zinc from 7½ cents to 4 cents per pound, tin from 20 cents to 14 cents per pound, and copper from 23 cents to 11 cents per pound.

In 1876 2,067 pounds of iron would purchase one ounce of gold; it now takes 3,858 pounds of iron to purchase one ounce of gold, and the purchasing power of other metals has similarly declined, as shown by the following table:

POUNDS OF METAL REQUIRED TO PURCHASE ONE OUNCE OF GOLD.

	1876.	1896.	Decline in Purchasing Power.
Iron	2067	3858	46 per cent.
Lead	344	636	46 "
Zinc	275	517	47 "
Tin	103	148	30 "
Copper	90	188	52 "
Silver (ounces)	17.3	30.8	44 "

If it be found that the cost of producing these metals has declined in proportion to their fall in value, the latter must be attributed to decreased cost of production, and not to increased value of gold.

In 1876 the blast furnaces of this country were producing iron from relatively lean and high-priced ores, and a furnace making 50 or 60 tons per day was doing good work. The furnaces of 1896, producing from 100 to 300 tons per day, smelting the rich and cheaply-mined Lake Superior ores, or operated with the cheap fuel and ores of the South, with improved regenerative hot-blast stoves and other accessories of modern practice, amply account for a decline in the cost of production equal to the decline (46 per cent.) in value.

In the lead and zinc industries we find vast improvements in mining methods, rock drills replacing hand drills, dynamite substituted for black powder, and a revolution in smelting and refining methods almost, if not quite, equal to that effected in the iron industry; and we can readily believe that the costs of lead and zinc have fallen 46 or 47 per cent. in the last twenty years.

The growth of the copper mining, milling, smelting, and refining industries, in the Lake Superior, Arizona, and Montana districts; the reduced costs of mining due to the adoption of power drills and high explosives; the massive steam stamps, doing the work of more than fifty ordinary stamps; and the improvements in copper-smelting methods and in electrolytic refining,—might easily cause a drop of more than 50 per cent. in the cost of production.

Cheaper smelting of the lead ores with which silver is usually associated has lowered its cost, and modern mining methods and appliances, and radical reductions in freight charges from the mine to smelters, and the facilities afforded the smelters of bringing together at moderate transportation charges proper assortments of ores to make good fluxing mixtures, have effected a decline in the cost of production that might readily cause a drop of 44 per cent. in its market value as compared with gold.

The principal features of present practice actively operating as factors in the decline in cost of producing all of these metals are effective in all countries where these metals are produced in quantity. In this country larger benefits have probably been reaped from the application of modern methods than have been obtained elsewhere, but all mining districts, in greater or lesser degree, have felt their influence, and, wherever the mining industries are controlled by civilized owners or managers, the advantage of power drills, high explosives, improved pumping, hoisting, crushing, and milling machinery, and modern concentrating, extracting, smelting, and refining processes are appreciated and to some extent utilized.

Within this twenty-year period tin has declined in value only 30 per cent. While its cost has been lowered by modern mining methods and appliances, and by improved machinery for crushing and concentrating its ores, a large part of the tin of commerce is obtained by washing its ore (*tin-stone*) from alluvial sands and gravels, somewhat as alluvial gold is mined; and the methods in vogue show little, if any, improvement. The smelting and refining of tin from its ore (*tin-stone* or *cassiterite*) has been done by cheap and efficient methods and appliances for many years, no distinctively modern innovations effecting material reductions in cost having recently been adopted; hence it is not difficult to understand why the value of tin has fallen only 30 per cent. in the last twenty years, while these other metals have suffered an average decline of 47 per cent. in the same time.

The writer will not venture upon a discussion of the decline in market value of agricultural and manufactured products during the same period, but believes a review of the improvements in methods, appliances, and transportation would show that the decline in values can be traced to reduced cost of production.

This general decline in the cost of producing metals leads one, naturally, to inquire whether the cost of producing gold has not declined in the same way, at the same time, and from the same causes, and, if so, why its value—*i. e.*, its purchasing power—has not fallen in the same ratio, in which event relative values and market prices should have remained unchanged.

The answer is sufficiently simple. The world's store of gold has been obtained, principally, from alluvial deposits,—from the washing of the gravel-beds of streams and valleys. As this placer gold is already in the metallic state, and as the cost of transporting it to market forms a very small fractional part of its value, the reduced costs of smelting and transportation so potential in lowering the cost of other metals have not appreciably affected its cost; and, as the mining of such deposits has not materially been cheapened in the last twenty years, the cost of producing gold from placer workings has remained practically unaltered by recent inventions.

Gold won by underground mining of gold-bearing veins or lode is divisible into three distinct classes; (1) gold from "free-milling ores," in which the gold exists in a metallic state; (2) gold from "partially free-milling ores," in which some of the gold is in a metallic state and the remainder is combined with some other mineral; (3) gold from "refractory" or "smelting ores," in which the metal exists in combination with other minerals or elements.

Gold produced from all classes of ores mined underground has been cheapened by improved mining methods and appliances, a portion of that from the second class has been further cheapened by lowered freight charges on concentrates from mill to smelter, and by improved milling, smelting, and extracting methods, while all of that extracted from ores of the third class has been cheapened by economies accruing from all of these improvements in the art.

Under the conditions governing gold mining in the past, the greater part of the production was obtained from alluvial washings,—*i. e.*, placer mining,—a considerable portion of the balance from free-milling ores, and only a small part of the output from refractory or smelting ores; but within the last five years these conditions have rapidly changed, so that now we appear to have entered upon a period in which the world's supply no longer will depend upon placer mines and free-milling ores, but will be obtained principally from deposits of refractory ores.

Improved roasting, matting, and smelting processes gave the first stimulus to this branch of gold mining; the development of cheaper and simpler chlorination processes and the cyanid processes quickly followed, and already have effected a revolution in the industry; and the end is not yet, for other processes and modifications of known processes are in sight, promising equally good or better results.

The cost of producing gold from refractory ores has doubtless fallen as much as the cost of producing iron, lead, zinc, copper, or silver; but, as gold so produced has formed but a small fractional part of the total output,—the change being recent and still in progress,—no perceptible effect upon the value of gold can yet be noted.

Any material change in the cost of producing the metals not used as money is marked at once by corresponding change in the market price, for the world's supply of metals (the stock on hand or visible supply) is but a small part of the output of a single year, and, as these metals are consumed as fast as they are produced, the market is dependent upon receiving a continuous supply of new material, and responds quickly to chunges in the cost of production, often discounting them in advance.

Gold and silver are less sensitive, because the stocks on hand are so large, the inertia of the mass so great, and the influence of tradition and past experience so strong, that years may elapse before a change in the cost of production creates a corresponding effect upon their market values or purchasing powers.

The decline in the cost of producing silver had been in progress for several years—affording mine owners opportunities for enlarged profits—before its market value became seriously disturbed; but the decline, once fairly inaugurated, progressed rapidly, until quotations reached figures lower than the average cost of production.

The wide distribution of the world's store of gold, its large volume, and the fact that it is held principally by those (both corporations and individuals) having no desire to part with it, but who retain it as a convenient medium for the investment of their surplus or otherwise uninvested wealth, prevent rapid changes in its value or purchasing power. Its fluctuations are correspondingly sluggish, the addition of a relatively small stream of cheaply-mined gold causing no immediate change in the value of the great mass with which it unites. But, as the volume of this stream is steadily and rapidly increasing, the purchasing power of the whole mass ultimately must recede, until it rests at the level of the cost of production, wherever that level may be found.

The closure of the mints of the most wealthy nations to silver, with the corresponding increased use of and demand for gold, assist in maintaining gold abnormally above its value as determined by the cost of production, thus retarding the fall that otherwise might already have commenced.

Were these conditions better appreciated, the world might even now be engaged in discounting future changes, as happened upon the discovery of the Californian and Australian gold-fields when gold rapidly declined, silver rising correspondingly and being stipulated in bonds for the payment of debts.

The discovery of a California or a South Africa is, however, of less real significance than the evolution effected in working refractory gold ores, for the effects of the latter are widespread, bringing within profitable working range refractory gold deposits in all parts of the world.

Exactly how much the cost of producing gold has declined cannot be stated, but the known facts indicate a decline of at least 30 or 40 per cent. and the decline may approach, or possibly exceed, 50 per cent.; but, notwithstanding this decline, its purchasing power as compared with other metals has increased 40 or 50 per cent. That this anomaly must disappear, that the purchasing power of gold—*i. e.*, its value—ultimately must fall as much as the cost of producing it has declined, cannot seriously be doubted. It seems probable that the factors already noted may retard this decline in value, and possibly it may be marked only by slowly enhancing values for all products, and may possibly occupy a period of several years, in which event the intervening period must afford extraordinary opportunities for the profitable operation of gold mines, mills, and reducing works.

All references to fluctuations in the rates of wages as affecting the cost of production have been excluded from this discussion of values, because fluctuations in wages, while important in some mining districts as affecting individual cases, appear trivial when averaged with wage changes in other countries, their effects being local, not general; because, if calculated on a gold basis, no general rise or fall in wages appears to have occurred in the last twenty years; because, although in several countries there has been an apparent and considerable decline in wages, this decline can safely be disregarded, as it should affect all industries in nearly the same proportion; and, finally, because the saving in the amount or quantity of labor required to produce a given quantity of any product (effected by modern improvements and labor-saving machinery and the advance in chemical and metallurgical operations) is incomparably greater than that accruing from any decline in the rate of wages.

The belief has gained wide currency that the present increase in gold production is limited to the development of newly-discovered districts,—*viz.*, the South African, Cripple Creek, and West Australian; that, when these attain their maximum, no further addition to the out put can be expected, except such as may come from the discovery of other deposits; and, as a corollary, that, barring such new discoveries, the output will thereafter decline. The considerations advanced in the foregoing pages, and the geologic and mining conditions known to obtain in nearly all mining districts, lead to very different conclusions.

In every gold-mining district, deposits exist, unavailable under the inefficient or expensive processes of the past, but which now can be worked to advantage. Placer deposits and free-milling ores are limited in extent and quantity, but the unfathomable deposits of refractory gold ores, existing in almost every mining district, may be worked upon a gigantic scale.

The enhanced purchasing power of gold should, even at the former cost of producing it, make gold mining one of the most alluring industries of the times. The furore among those alert to seize upon opportunities for profitable investments shows that increased value with decreased cost of production are recognized even while the causes producing them may not fully be understood.

The readjustment of the value of gold to its present reduced cost of production should be marked by a period of activity and prosperity in all classes of enterprise. With rising wages, and rising prices for all products, should come increased ability to discharge debts and obligations of all kinds; and with enhanced values should come such renewed confidence in the future as will prompt men to undertake those vast constructive enterprises which furnish employment and lighten the burdens of mankind. The writer believes we are entering upon a period of unexampled prosperity, which shall have, as its most potent factor, an enormous addition to the world's store of gold.

QUACKERY IN ENGINEERING EDUCATION.*

By Edgar Kidwell.

THE articles on "Education of Mechanical Engineers" in the December issue of this magazine are of more than ordinary interest to the educational world. In the paper by Mr. Emery we find sound advice and pertinent suggestions which at once stamp their author as a man of profound observation and extensive practical experience in engineering and investigation. In marked contrast to this is the paper of Mr. Thurston, which presents no new ideas on education, but rather a reflex of opinions unhappily too prevalent in our engineering schools. He again echoes the old cry that the profession which he is following "is coming to be one of the most truly learned, if not actually *the* most learned, of all the professions," and presents the usual array of magnified statements as to what is accomplished in technical schools. Such assertions are greatly to be deprecated, since in the end they mislead the uninitiated and produce only harm. The tendency to put forth such questionable statements is unfortunately on the increase, which fact furnishes ample proof of the existence of the evil that forms the subject of this article.

By quackery is here meant any promise or pretence to do that which cannot be done, either because the thing is in itself impossible, or because he who made the promise knew that the means to execute it were wanting.

The trustees of a technical school are usually selected, not because they are experts in education, or have more than a passing interest in it, but on account of their high position in life, or because they have a solid bank account. Since the position is one that adds to their prominence, men eager to shine before the public frequently accept it without any intention of burdening themselves with the cares certain to come if the duties of their office are efficiently discharged. These men are not able to formulate accurately the qualifications necessary in a professor, and hence their selections are often unwise. They are frequently influenced in their choice by religion or politics, and especially by the kind of reputation which a candidate for a chair has obtained by mere declamation in public and

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* We invite a perfectly free and frank discussion of the subject here broached,—alike from those engaged in educational work, from college graduates, and from practical men. The space necessary for the statement of all essential facts will be gladly accorded, but participants in the discussion will readily appreciate the necessity for brevity.—THE EDITOR.

keeping his name in print. A searching investigation into the candidate's real fitness for his duties is very rarely made.

Erroneous statements of what the school can do are a most fruitful source of educational deception, and are due very largely to the appointment of the kind of men just mentioned. They have done more to injure technical education in the estimation of the public than any other single cause. Students spend four years at college; follow a course often poorly laid out and inefficiently taught; get an idea that they are exhausting the subjects they are studying; imagine that a smattering of work-shop or laboratory practice has made them into engineers; and on graduation day go forth with the conviction that they are about to conquer the engineering world. This is unjust to the student, since it makes him inclined to dictate to his superiors; it is more unjust to the employer, who is obliged to convince the young men of their error. Managers of engineering concerns have no time to waste on such work, and very properly claim that it is no part of their duty. Their feeling in this matter is fully expressed in the following statement, made by an eminent engineer employing thousands of men, many of whom are technical graduates: "By far the most important thing these schools need to do just now is to disabuse their young men of the idea that on commencement day they are prepared to occupy the office of manager and run the whole place; next to that, let the schools be honest, and, when they give the student a lot of mere theory, then tell them it is mere theory, and not delude them with the idea that it is practical engineering." The evil thus deplored will continue as long as we find heads of technical schools ready to make, *ex cathedra*, such statements as the following: "Even in the instruction in manual training . . . . the student, under the tuition of an expert, and following the systematic course laid out for him, becomes singularly expert in a wonderfully short time. The equivalent of a few days' work makes him a good smith, and he welds iron with facility and certainty; the equivalent of a few weeks' work at the anvil makes him a good worker in steel, and he makes and tempers his own tools with entire success. In the foundry he quickly learns the principles of his art, and it becomes difficult to find a pattern that he cannot handle. In woodworking and machine-shop practice he quickly learns to handle tools with the ease and skill of an 'old hand.' All this is done, not to make him a good mechanic in the usual sense, or to teach him a trade, but to enable him to design intelligently, to criticise good and bad work, to indicate the best methods of doing the work directed by him, and to guide the workman intelligently."* If these statements mean the

* From Mr. Thurston's article in the December issue of this magazine.

same to Mr. Thurston that they do to engineers and mechanics, then they furnish a sample of exaggeration and bad logic. They are not true, and never can be. The most brilliant student who ever graced a school cannot become a good smith in a few days or a few months. A few days will not suffice to teach him to "strike" like a professional, or develop his muscles sufficiently to do so. If one of these men should try to bore out an eight-foot cylinder, he would soon drop the idea that he can handle tools "like an old hand." Since he who is himself ignorant of how to do a thing cannot guide another who does know how to do it, it is a travesty on logic to talk of such a man "indicating the best methods of doing work, and guiding the workman intelligently."

The writer is heartily in favor of work-shop practice in schools, and has under his charge a shop which, in point of equipment and competent instructors, is fully the equal of the one alleged to have produced the results mentioned by Mr. Thurston. Extended experience with this and other shops has shown the writer that from the very nature of things such results cannot be obtained here, or in any other school, whether these institutions admit this fact or not. A student is by no means a good smith, or expert engineer, because he can weld up a broken valve stem, or adjust a valve gear; there is no glory in teaching such simple matters; it is our duty to teach them, and, if we do not, then for what is our school really fit?

The only legitimate object of a technical course is to give instruction in the principles underlying all engineering, and to familiarize the student with such practical applications of these principles as can be learned at school more quickly than elsewhere. Within the limits of equipment which any school can find the time and means to operate, it will be impossible to handle any large practical problem or constructive work. What is taught can be well taught, and there is absolutely no necessity for the amateurish and unmechanical work done in many school-shops. But, no matter how well the work is executed, it is necessarily small in size and limited in its range of subjects; hence such work cannot produce good smiths, or any other kind of mechanics; to claim otherwise is educational quackery, and the writer appeals to every experienced engineer to say whether this statement is not literally true.

Another form of quackery is found in the specious wording of catalogue matter. The catalogue is the school's letter of introduction to the public. Through it the majority of the people have to draw their conclusions respecting the intentions and equipment of the institution. It is, therefore, clear that any catalogue statement which, by specious wording, leads one to infer that the school possesses certain material when it does not, or that it is prepared to teach properly certain branches, when it really is not, is evidence of quackery. Yet few catalogues are specific enough to give an accurate idea as to just what work the institution is really prepared to do. All through we find such stereotyped phrases as "a large equipment," "electrical laboratory and lecture-room, with all requisite appliances," "well-appointed library," "laboratory with all the instruments needed for a complete and thorough course in physics," etc. Such phrases tell nothing, and the writer has invariably found their use indicative of poverty. There is not in this country to-day a laboratory equipped with "all the instruments needed for a complete and thorough course" in anything, since new discoveries occur faster than we can provide apparatus to illustrate them, even if we have unlimited money.

A certain school undertook the herculean task of training men for mechanical engineering, without providing any shops or mechanical laboratories. To gloze over this fatal deficiency in equipment, it states in its catalogue that "the student enters the shop* with hands and mind free to examine all processes, operations, and machinery (?), and is ready at the call of the teacher to witness any operation of special interest. Provided with note-book, pencil, calipers, and measuring rule, the student sketches the most important parts of the various machine-tools, notes down the successive steps of each of the important shop processes, as illustrated by the pieces operated upon, and follows the pieces of work through the shops, from the pig or merchant form to the finished machine." In other words, at this institution engineering is to be learned by "looking on." What would be thought of a school which pretended that chemistry can be learned by watching a teacher manipulate apparatus? In both these cases the knowledge acquired is merely superficial, and to claim otherwise is an attempt to mislead the public.

The spirit of rivalry between institutions tends to foster quackery. It does not logically follow that, because one institution, to meet a legitimate demand, has established a certain course and made it a success, all other schools should establish a similar course; yet the spirit of rivalry between schools is causing this very thing to be done repeatedly. A director who wants to boom himself advocates this policy, and it is usually very alluring to a board which does not see the "true inwardness" of the matter. Departments for which there is no real demand are established, buildings are erected, professors are appointed, a great noise is made before the public, and a new specimen of educational quackery is inaugurated. The equipment and assistants neces-

* An outside shop which the student is visiting.

sary to make these new departments a success are not provided, and only a beggarly sum is allowed for current expenses. The work done is of a most inferior grade, and does not properly prepare the student for his future.

Often, again, instead of genuine equipment, we find that "the larger and better schools usually operate, as a piece of scientific apparatus, an 'experimental steam-engine,' representing $10,000 to $15,000, and working up to perhaps 200 h. p. in some cases, and costing large sums daily for its operation."* This kind of thing makes a great show. It gulls the capitalist who has some money to donate, and it deeply impresses the papas and mammas of prospective students, and—that is about all of it. There are several of these engines in use, and certain institutions are trying to obtain money to purchase more of them. Yet what results has any one of these machines produced? Has a single fact of any value to, say, the Edw. P. Allis Co., or any other builders, ever been learned from them? If not, then for what are they really good, except to give the student practice in starting, stopping, and testing, all of which can be done just as well on an engine costing not over $700? The writer considers them mere show-goods, purchased through mistaken judgment, or purely for advertising purposes. If the money these machines cost had been judiciously expended on apparatus and books selected for the real benefit of the student, it would have been more wisely invested, and would also prove that Mr. Thurston's statement that $1,000,000 is needed to "make a beginning" for a technical school is an assertion having no basis in fact. If money is wisely expended, and the officials attend strictly to their legitimate business, instead of trying to run a department and at the same time conduct a lot of tests for money, or turn out a multitude of books with paste-pot and scissors, or supervise half-a-hundred draftsmen getting out plans for a town-sewerage system, then some educational results superior to the usual grade can be got, and for much less than $1,000,000 "as a beginning."

Again, the financial embarrassment caused by the show-policy produces evil results in the retention of incompetent students. When an institution charging tuition fees is pressed for money, and there are fifty to one hundred mediocre men in its classes, it rarely drops out any but the very worst. An incompetent hangs on for years, his length of stay and his good intentions are finally considered the equivalent of some good work, and he gets a "sheepskin." He is a failure later, and has wasted valuable years of his life,—years which might have produced golden results, had his professors been conscientious enough to turn him out of their classes, and advise him to take up some work

* Thurston, *loco cit.*

for which nature had intended him. The writer is firmly convinced that the worst evil in the so-called education of to-day is the almost universal practice of schools trying in every way to increase their attendance, without any regard whatever as to whether their students properly belong in such a school. Boys whose parents have to slave for years to educate them and are wholly incompetent to decide what their sons should be taught are unhesitatingly admitted into classical and literary courses, and toil for years on the ancient languages, general literature, and philosophy, and are fully prepared for the holiday of life. New thoughts, longings, and ideals are bred into them; yet their training is like the cup of Tantalus,—it gives them absolutely no means of satisfying the desires it has created. When they graduate, they are incompetent to earn their living; they have no money, influence, or connections to help them to that station in life for which they have been fitted at school; they are forced to accept positions the very environment of which makes their knowledge a source of misery to them. Is it not wrong, in fact, criminal, to wreck one's happiness in this way, merely that the college register may be lengthened a little? The writer thinks so, and that it were far better to teach such young men a trade, or send them to a business college, or do anything else with them, provided they are taught to earn their bread, and be self-sustaining.

One of the very worst forms of educational quackery is due to the prevalent custom of allowing professors to conduct an engineering practice outside of their school duties. The inevitable result is a rapid diminution of the professor's usefulness and honesty, since such work is liable to wholly engross his time, and is destructive to the morals of his students. In the early part of their college course, if not all through it, students are prone to idealize a professor somewhat; and, when they see him cheating them of the time and instruction which are their just due, what is more natural than that they should conclude that engineering is a cheating business all through? When men of experience in such matters read in the journals the advertising cards of consulting engineers, chemists, metallurgists, etc., inserted by technical professors, they can draw but one conclusion,—that every man who does this thing will, for mere money, do over and over again work that adds nothing to his mental acquirements, and thereby waste his own time and that of his students. No man can do this, and at the same time attend faithfully to the various duties which are inseparably connected with the proper supervision of an engineering course; therefore, an institution which permits it is guilty of educational quackery. This becomes of even a ranker kind when the professor, instead of laying out the course of training best for the student, uses him as a mere assistant in private work, narrows his opportunities of learning, and puts the proceeds of the student's labor into his own pocket.

Lest there be some who think that the above statements are not based on actual fact, the writer will mention a few cases that have come under his observation. Those who care to investigate can find many more just as bad.

Some years ago a leading school appointed a professor in one of its chief departments. This professor then got a further appointment on the faculty of another college, and also took upon himself a third duty by accepting a civil office. Lest he should be burdened by a surplus of time, he opened a commercial and semi-professional establishment, took in all kinds of work, and kept busy a number of private assistants. His appearance in the class-room was narrowed down to a few hours per week; what he said when he did appear amounted to nothing; and, when an extra pressure of outside work occurred, he cancelled even those few hours. Would it be much short of a miracle if that man's teaching was of any value? When his students left school, and, too late, woke up to the fact that they had learned nothing, did they not have just cause to consider themselves swindled by their *Alma Mater?* Yet this man's name still stands in the school catalogue as a bait for students, while he continues to fish for dollars at the expense of his teaching.

So long as the foremost men in prominent schools dabble in just this sort of work, is it to be wondered at that the professors under them go in heartily for it, and that much of the equipment of such a school looks like an aggregation of ancient relics. As long as the students do not rebel, and parents are perfectly satisfied, it is not probable that any change for the better will be made.

The case which perhaps appeals most strongly to the writer is the following. A certain prominent university had at the head of one of its engineering courses an able man,—one who has earned his fame as a successful engineer. He accepted the position of chief engineer of a large corporation, started to design and erect a plant costing several millions of dollars, and had to hasten the work to finish in time. Though the authorities of that school were fully cognizant of the facts, this man continued to hold his professorship, and day after day he appeared in the class room totally unprepared. He explained nothing, read occasionally a "lecture" out of an ancient note-book, and then whiled away the remainder of the time in giving excellent moral advice which he himself never followed. Was it any wonder that, when the year was over, not a student in that class could compute the thickness of a board for the top of a bench, and feel enough confidence in the result to sit on the bench when finished? One of those students early found out his deficiencies; they were later made up by hard study during hours which should have been devoted to sleep; but that student determined then and there that, should he ever have anything to do with education, he would strain every nerve to keep quackery out of it, and he has kept to his resolution.

Strict accuracy is essential in all engineering teaching and publication. Yet the longing to keep before the public which is so prominent in some men leads them to issue engineering literature which is extremely inaccurate, and perhaps responsible for serious mistakes. Surely such statements as the following cannot do otherwise than mislead the engineering tyro:

> Hemlock Spruce Fir (*Abies Canadensis*) is found in the same range of climate as the black spruce, but it prefers a more hilly country. It forms extensive forests in Lower Canada. It attains a height of 70 feet (20.73 meters), and occasionally even 100 (30.5 meters), and reaches a diameter of 2 feet (0.61 meter). The leaves are dark and stiff, four-sided and needle-shaped. The cones are ¾ or 1 inch (1.9 to 2.5 centimeters) long. The wood resembles that of the white spruce, and is generally more highly valued. Its strength, durability, lightness, and elasticity form a combination of good qualities that makes it, for some purposes, the best wood in our markets.

The *habitat*, metric measures of the cones, and configuration of the leaves may be very important to somebody, but what an engineer wants to know is that hemlock is a rather hard, extremely brash, and treacherous wood, liable to crack open in the rings, and is usually so wind-shaken that the interior is a mass of splinters; hence this wood is used in only the most inferior class of structures, and in some localities it is not considered worth cutting for the market, even for firewood. So long as this grade of engineering authorship can gain a man a "reputation" with the public, we cannot hope to see the proper kind of education given in our technical schools.

THE VAST IMPORTANCE OF THE COKE INDUSTRY.

By John Fulton.

THE trend of general investigation in manufacturing industries is usually toward ultimate results; only limited attention is afforded to the relative importance of the elements which contribute to these products. The genesis and sources of the elementary materials for manufactures, whose combination contributes so largely to man's comfort, civilization, and power, are overlooked entirely, or relegated to inconsiderate positions.

The fact is that these exist in such abundance that we are led to overlook their real importance, our familiarity shading the values of these essential elements that render possible the marvelous growth of our manufactures.

If some great revulsion were suddenly to arrest all movements of our railroad systems, and travel and freight were compelled to seek the old-time stage-coaches and the Conestoga wagons, what a shock would be given to the body politic! The great value of the railroad service would be realized to an extent not hitherto appreciated. The same is true of fuel supplies in all metallurgical operations. If iron and steel manufacturers were compelled to go back to the exclusive use of charcoal fuel, an immediate and large reduction in output would follow, with most alarming consequences; rapid depletion of the forests would ensue, ending in their exhaustion.

Even by the use of the more compact mineral fuel, anthracite coal, with its slow combustion in smelting operations and increased costliness, the present output of metals could not be maintained. And, like the charcoal fuel, the supply from the five hundred square miles of anthracite coal area would suffer similar decrease and exhaustion at a time not far distant.

With coke the case is entirely different, as coke enjoys permanent sustentation from the coal in the two hundred and fifty thousand square miles of coal fields in the United States. The supply of this most excellent metallurgical fuel may, therefore, be regarded as *practically inexhaustible.*

As the coal for the manufacture of coke is distributed widely over the United States, a uniform moderate cost is assured.

The order in which these fuels have secured supremacy in metallurgy is shown in the table on the following page.

Years.	Charcoal.	Anthracite Coal.	Coke.	Remarks.
1854.	342,298	339,435	54,485	All net tons.
1855.	339,922	381,886	62,390	Anthracite leads charcoal.
1869.	392,150	971,150	553,341	Coke leads charcoal.
1875.	410,990	908,846	947,545	Coke leads anthracite coal.
1890.	703,522	2,448,781	7,154,725	Era of coke.

From this table* it appears that it required time to assure furnace managers of the relative values of these fuels, considering cost, calorific energy, and quality of pig-iron. However, during the thirty-six years of testing, the large advance in the use of coke is remarkable. Evidently it is destined to maintain its present supremacy as the metallurgical fuel.

The early efforts in the manufacture of coke followed, in a modified manner, the methods used in making charcoal.

The coal was piled in heaps, or mounds, somewhat similar to the *meiler* mounds of charcoal, with the usual flues for firing and burning, and billets of wood for starting the carbonizing process. During the progress of coking, the burning is arrested by banking the mound with fine coke-dust. It is needless to add that this method was wasteful of the coal, producing a coke of inferior quality, chiefly owing to the irregularity inherent in this plan of manufacture.

This primitive period of coke-making was followed at successive intervals by the three typical coke-ovens now in general use,—the beehive, the vertical retort, and the shaft or Appolt ovens. The position of the coal in coking in these ovens has been illustrated by the use of a common red brick. Laid on its broad side, it represents the coal in the beehive oven; on its narrow side, the vertical family of coke-ovens; standing on its end,.the shaft or Appolt type of oven.

The beehive oven.—Some advocates of the modern types of coke-ovens have wasted considerable effort in undervaluing this "ancient oven"; but, like the Israelities under the persecutions of Rameses in Egypt, they have increased and multiplied, until at present, with the exception of less than two hundred, they constitute the whole of the forty-five thousand ovens in the United States.

The beehive oven evidently took its form from the old time beehive, and its operation from the old round oven for baking bread. The following plans and sections will show the ancient and modern conditions of this oven.

The initial or old-type beehive oven was diminutive in size and inefficient in action. The modern oven is circular, with a diameter at base of twelve feet, and a height (of the interior of its dome) of seven feet above the floor. An oven of this size, with good coking coal, will

* Mr James M. Swank—"Iron in All Ages."

COAL-HOISTING PLANE AND BEEHIVE OVEN PLANT. H. C. FRICK CO., YOUNGSTOWN, CONNELLSVILLE REGION.

DRAWING COKE FROM OVENS.

produce four tons of excellent marketable coke in forty-eight hours.

During the past decade the operations of coking in the beehive oven have been much improved, securing an increased percentage of coke, with more thorough and complete carbonization. Carefully-conducted tests at the coke works of the Cambria Iron Company, in the Connellsville region, Pennsylvania, give the following results:

No. of tests. Averages.	Coal charged. Lbs.	Time in oven. Hs. Ms.	Market coke made. Lbs.	Fine coke or Breeze. Lbs.	Ashes. Lbs.	Per cent. of yield.				Per cent. lost.	Remarks.
						Market coke.	Breeze, Small coke.	Total coke.	Ash.		
4.	10 385½	43.28	6987¼	77	244	67.28	0.74	68.02	2.35	29.63	Watered in oven.
2.	9.910	44.00	6591	119	229	66.50	1.20	67.70	2.31	29.99	Watered when drawn.
2.	11 965	70.00	7850	137½	244	65.61	1.15	66.7[illegible]	2.05	31.19	Watered in oven.

The proximate analysis of Connellsville coal is as follows:

Moisture 212° F.	1.25 per cent.	Volatile matter	31.80 per cent.
Fixed carbon	59.79 "	Ash	7.16 "
Sulphur	0.53 "	Phosphorus	0.024 "

The *theoretic coke* from this coal is 67.27 per cent., made from the following elements:

Fixed carbon	59.79 per cent.
Ash	7.16 " "
Sulphur	.32 " "
Total	67.27 " "

The average of the 48 hours coke, watered in oven, is 67.39

per cent. About 8 per cent. of carbon is consumed in the oven, but this loss is fully compensated by deposited carbon from the tar gas evolved in coking. This deposited carbon gives the bright silvery glaze that distinguishes the Connellsville and other beehive-oven cokes.

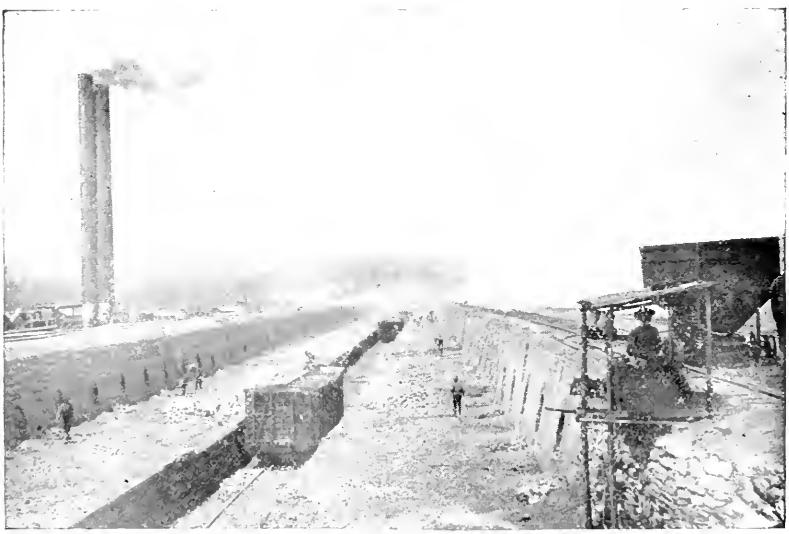
The vertical retort ovens.—This modern family of coke ovens had its genesis in the difficulty of coking the inferior dry coals of continental Europe in the beehive oven. The Knab oven of 1856 is usually regarded as the initial or root type, from which all the succeeding retort coke-ovens have been evolved. They consist of a series of vertical chambers 30 feet long, 16 inches wide, and 5½ feet high.

The coking-chamber has side and bottom flues, from which the heat for the carbonization of the coal is transmitted. This heat is derived from the combustion of the gas evolved in coking, deprived of its tar and ammonia, and returned to these flues for the necessary heat-supply.

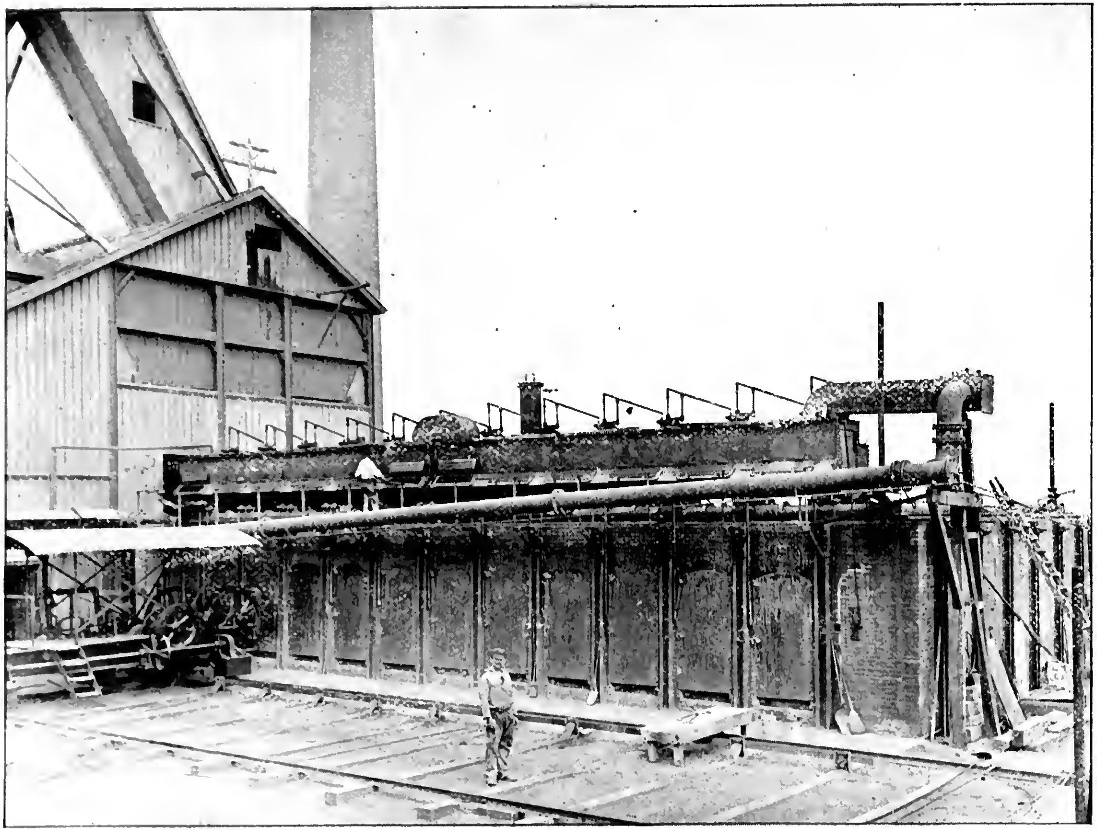
Theoretically no combustion of carbon takes place inside the oven, as no air is admitted into the coking-chamber. The following plan and sections will convey a general idea of the structure of these ovens.

These coke ovens accomplish, by their construction and operation, a three-fold service.

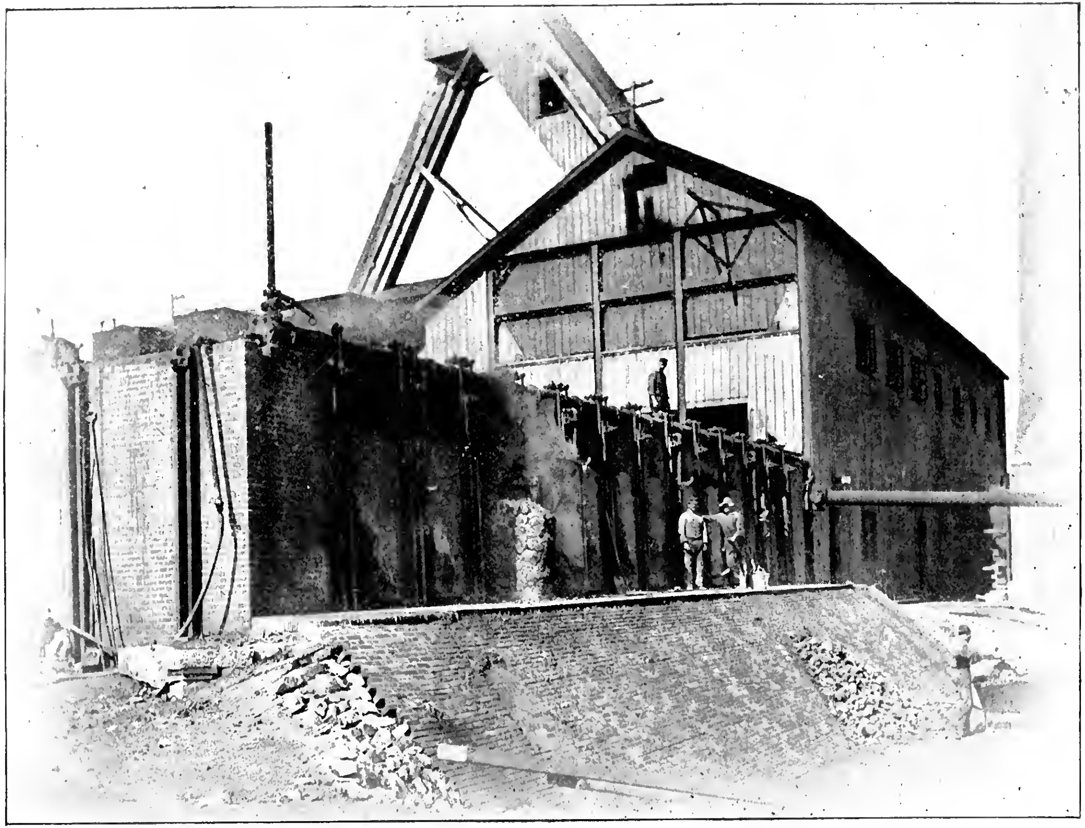
(1) By their continuous heat, they utilize the small volume of fusing matter in the "dry" coals. (2) They produce a larger per-



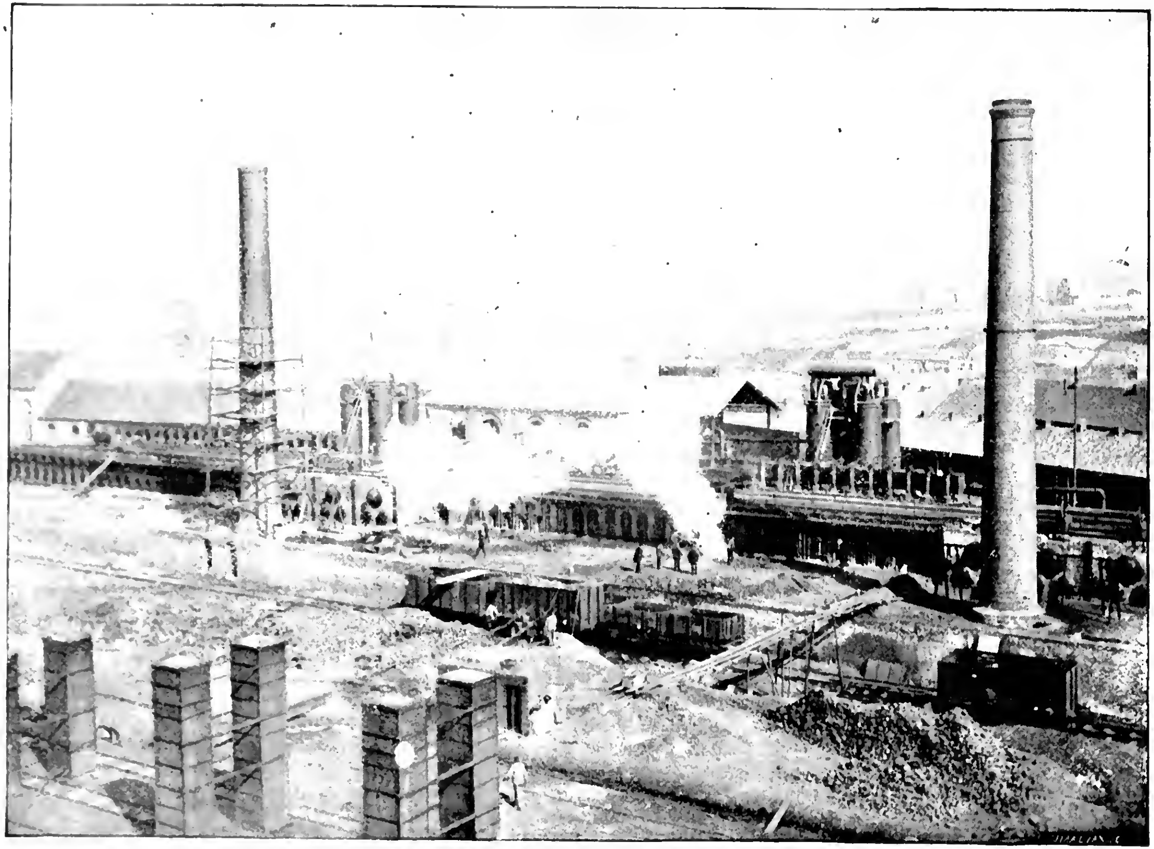
COKE OVENS. PRATT MINE, ALABAMA.



SEMET-SOLVAY RETORT COKE OVENS AT SYRACUSE, N. Y. VIEW FROM FRONT, SHOWING PUSHER.



SEMET-SOLVAY RETORT COKE OVENS AT SYRACUSE, N. Y. VIEW FROM BACK.—DISCHARGING.

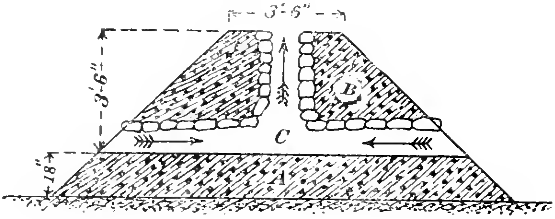


48 SEMET-SOLVAY RETORT COKE OVENS AT PHŒNIX WORKS, RUHRORT, GERMANY.

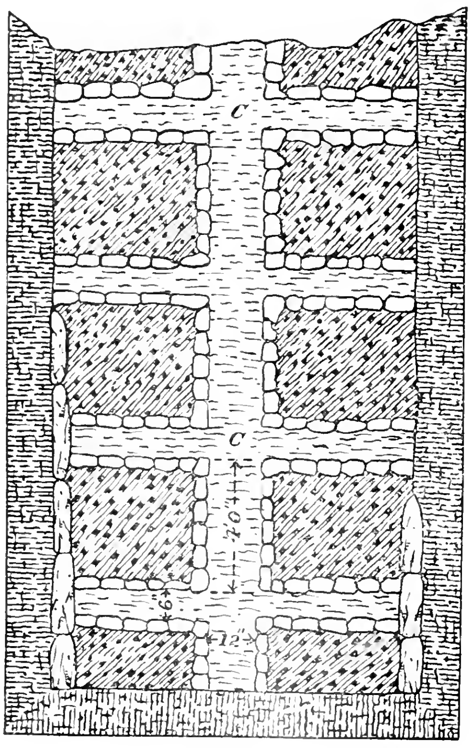
centage of coke than the beehive. (3) They economize the labor of drawing out the coke, by the use of a mechanical "pusher."

Supplementary to these economies, the by-products of tar and ammonia sulphate are saved, by exhausting and condensing the gaseous products evolved in coking.

The following are the chief competitors for public recognition at this time: Simon-Carvés, Semet-Solvay, Hüssener, G. Seibel, Otto Hoffman, and Festner-Hoffman.



Cross Section.

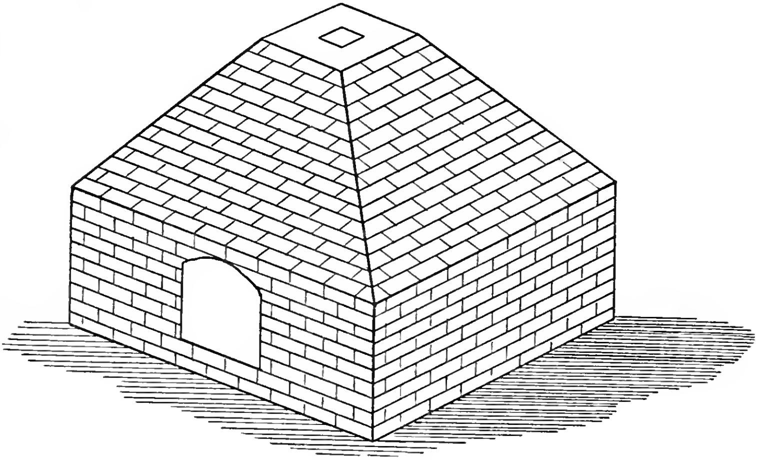


Ground Plan.

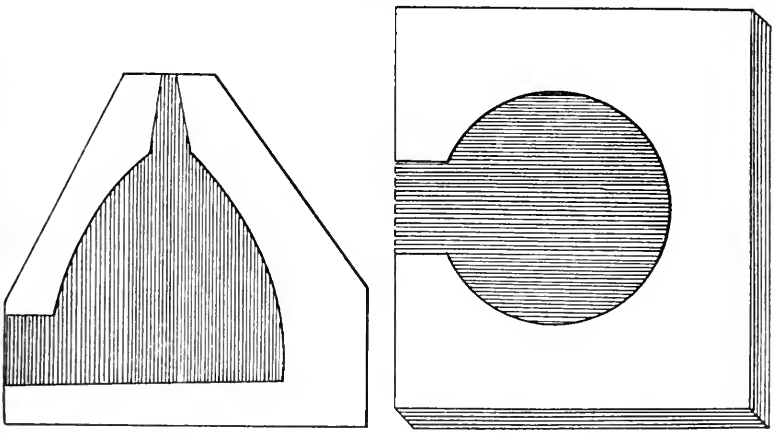
BENNINGTON COKE PITS.

A bank of twelve Semet-Solvay retort coke-ovens has been in operation for the past three years at the large chemical works of the Solvay Process Company, Syracuse, New York. A thorough test was made at these ovens in May last, at the request of Mr. A. G. Moxham, president of the Johnson Company, of Lorain, Ohio. This test, with 2,058½ tons of Connellsville coal, developed the work of this oven accurately. It made, in two careful tests, an average of 71.035 per cent. of coke from this coal. The theoretic coke from it is only 67.88 per cent., exhibiting a large gain in deposited carbon. With well-sustained heat, good furnace coke can be made in twenty hours. Each oven will produce

PLAN OF COKE OVENS NEAR NEWCASTLE-UPON-TYNE.



A.D. 1765.



SECTION. GROUND PLAN.

an average of four tons of coke per day. A plant of fifty Semet-Solvay retort coke-ovens is now being constructed at the Dunbar Furnace, in the Connellsville coke region, Pennsylvania.

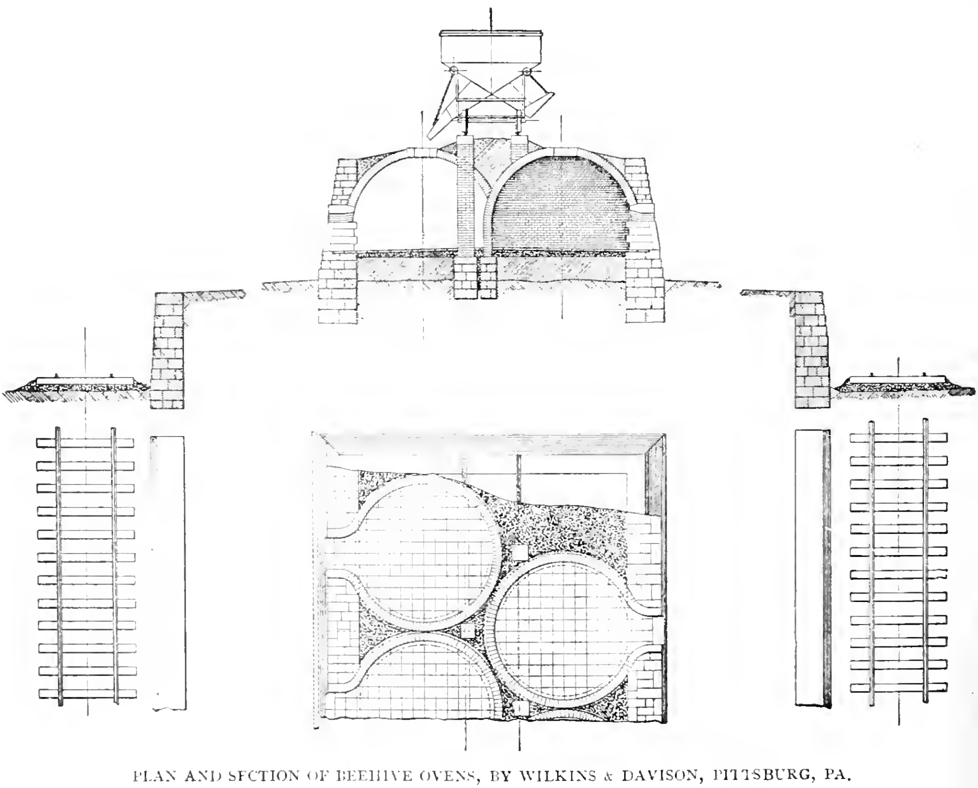
The Hüssener coke oven is very similar to the Semet-Solvay, but has thicker lining in its heating flues. Some recent efforts have been made to reduce the thickness of the interior lining of these flues. This oven is a very substantial retort.

The G. Seibel ovens have also much in common with Semet-Solvay ovens. The plan and section following exhibit a plant of forty-eight of them.

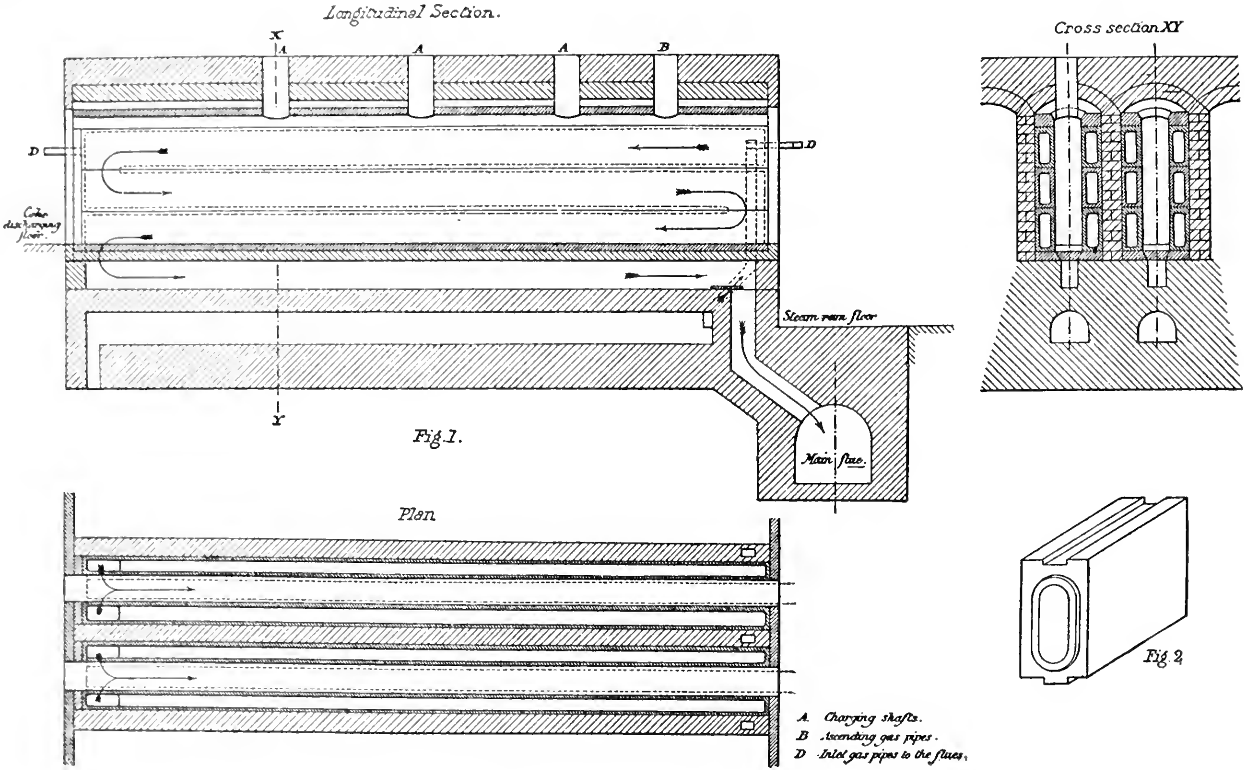
The Otto-Hoffman oven has chambers 33 feet long, 16 to 24 inches wide, and 5 feet 3 inches high. It has vertical side flues. The accompanying drawings show full details.

This oven has very complete condensation and ammonia factory plants attached. A plant of sixty of these ovens, producing coke for the Cambria Iron Company, at Johnstown, Pa., cost, with appliances for saving by-products, $301,500.23, or $5,025 per oven. It is reported that it is designed to add sixty ovens to this plant, making in all one hundred and twenty. The cost of the sixty additional ovens is estimated at $166,000, showing the cost of each oven, without apparatus, to be $2,766.66. This plant, when thus reinforced, will have cost, including the by-products-saving appliances, $3,895.83 per oven.

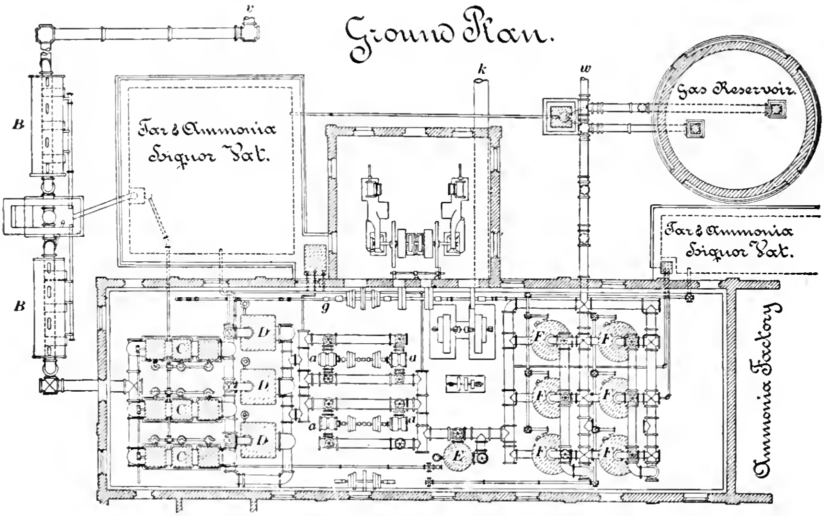
The Festner-Hoffman Oven.—The general design in planning this



PLAN AND SECTION OF BEEHIVE OVENS, BY WILKINS & DAVISON, PITTSBURG, PA.



SEMET-SOLVAY COKE OVEN.



CONDENSATION PLANT AT THE JULIENHUTTE.

oven is to economize in its construction and operation. The following drawings illustrate its general design.

It will readily appear that the recuperative compartments of this oven are less expensive than the double regenerators of its prototype, the Otto-Hoffman oven. It will also be noticed that its heating flues have been given the horizontal posture, which is undoubtedly an improvement. It has also the further advantage of direct or continuous heat appliance. Dr. Slocum, of the Gas Engineering Company, of Pittsburg, Pa., has designed an oven after the Hüssener type, but with the thickness of the flue lining very materially reduced,—a step in the right direction.

It will be noticed that the differences in the structure of the retort class of ovens consist more in details than in organic principles. Modern practice is sustaining the horizontal-flue system, with reduction in thickness of flue lining, through which the heat is transmitted to the coking chamber. This thinning of the flue lining secures economy in the rather costly regenerator and recuperator attachments to some of these ovens.

The following table exhibits the approximate relative value of these ovens in the manufacture of coke and saving of by-products.

The initial work thus far, in the introduction of the retort coke-ovens in the United States, has afforded very few reliable data as to the actual cost of ovens and their by-product-saving appliances. This is evident from the fact that the cost of such plants in Germany,

TABLE EXHIBITING THE RELATIVE ULTIMATE ECONOMY OF PLANTS OF THE THREE TYPICAL COKE-OVENS,—SINKING COST IN 20 YEARS.

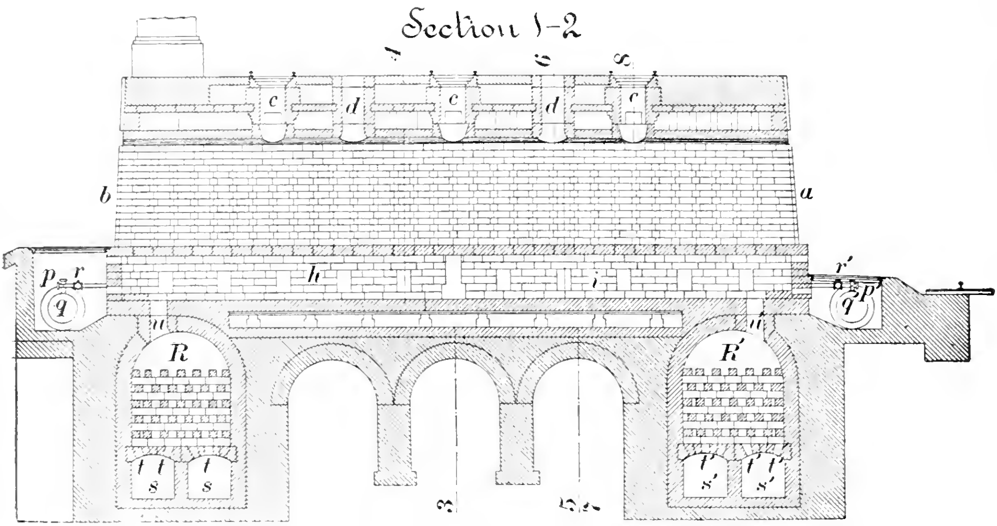
Name of Ovens.	Cost per oven.	Cost of condensing plant per oven.	Total cost per oven.	Time in coking. H. M.	Daily output per oven, net tons.	Number of ovens to make 118,800 net tons per year.	Total cost of plant.	Maintenance and repairs 5 per cent. per year on investment.	Maintenance and repairs per ton coke.	Sinking plant in 20 years, per ton coke.	Labor making coke and saving by-products.	Total cost per ton.	Per cent. of coke made.	Value of units of coke over 65 per cent.	Value of by products per net ton coke.	Ultimate cost for net ton coke.	Remarks.
Beehive	$ 300	$—	$ 300	48.00	2.0	162	$ 48,600	$ 2430	$0.02½	$0.02½	$0.35	$0.40	65	—	—	$0.40	Not saving by-products.
Thomas	800	—	800	48.00	3.9	84	67,200	3360	0.02¾	0.02¾	0.32	0.37½	65	—	—	0.37½	" " "
Belgian	1000	—	1000	48.00	2.7	120	120,000	6000	0.05	0.05	0.30	0.40	69	0.07	—	0.33	" " "
Coppée	1000	—	1000	48.00	2.3	141	141,000	7050	0.06	0.06	0.30	0.42	70	0.08¾	—	0.33¼	" " "
Bernard	1200	—	1200	48.00	2.5	130	156,000	7800	0.06½	0.06½	0.30	0.43	70	0.08¾	—	0.34¼	" " "
Simon-Carvés	1300	1000	2300	48.00	2.3	141	324,300	16,215	0.13½	0.13½	0.45	0.72	71	0.10½	0.32	0.29½	Saving by products.
Semet-Solvay	2000	1000	3000	22.00	3.7	88	264,000	13,200	0.11	0.11	0.45	0.67	71	0.10½	0.32	0.24½	" "
Hüssener	2000	1000	3000	48.00	3.3	98	294,000	14,700	0.12	0.12	0.45	0.69	71	0.10½	0.32	0.26½	" "
G. Seibel.	1700	1100	2800	48.00	3.0	108	302,400	15,120	0.12¾	0.12¾	0.45	0.70½	71	0.10½	0.32	0.28	" "
Otto-Hoffman	2300	1300	3600	36.00	3.3	98	352,800	17,640	0.14⅔	0.14⅔	0.45	0.74⅓	71	0.10½	0.32	0.31¾	" "
Festner-Hoffman	2100	1100	3200	36.00	3.2	101	323,200	16,160	0.13⅔	0.13⅔	0.45	0.72½	71	0.10½	0.32	0.29¾	" "

NOTE: It is assumed, in the above table, that the Connellsville coal is the base of facts as estimates in all the products.

France, and England affords no safe guide to their cost in the United States, as these introductory plants require the importation of much of the materials for their construction besides involving abnormal expense in the difficult and intricate work in their erection.

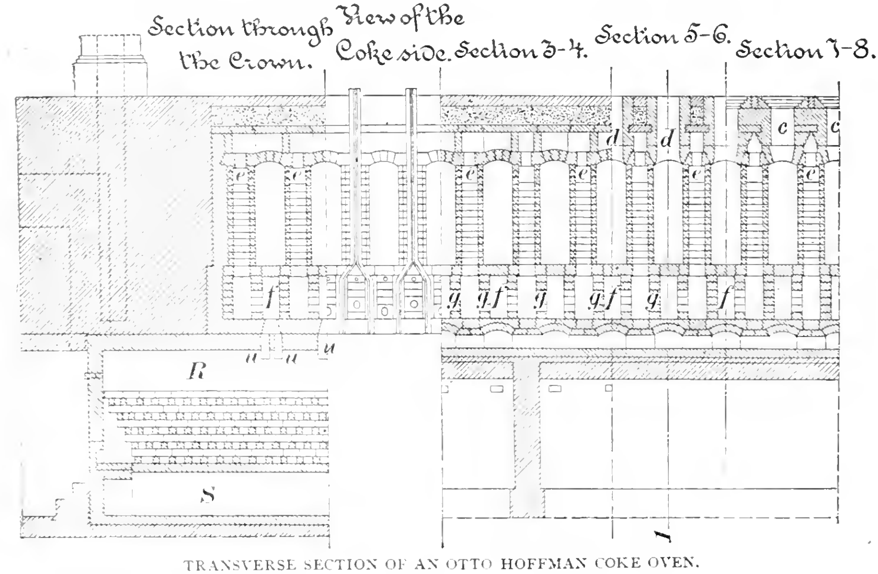
Two chief difficulties confront the introduction of these ovens: (1) the large cost of the plant; (2) the necessity of continuous work. But, as the coking of the "dry" or secondary coals becomes a necessity, these retort coke-ovens will come into general use. Recent investigation has disclosed the fact that their value is not confined to the coking of the "dry" coals exclusively.

It has been found that some of the beehive coke made from the



LONGITUDINAL SECTION OF AN OTTO-HOFFMAN COKE OVEN.

coals very rich in bituminous matter splits up into finger-pieces when charged into blast furnaces,—a fact which causes some hesitation about using it. The explanation of this undesirable result is, in most instances, evidently in the fact that all the coals very rich in bituminous matter swell greatly in the freedom afforded in a beehive oven;

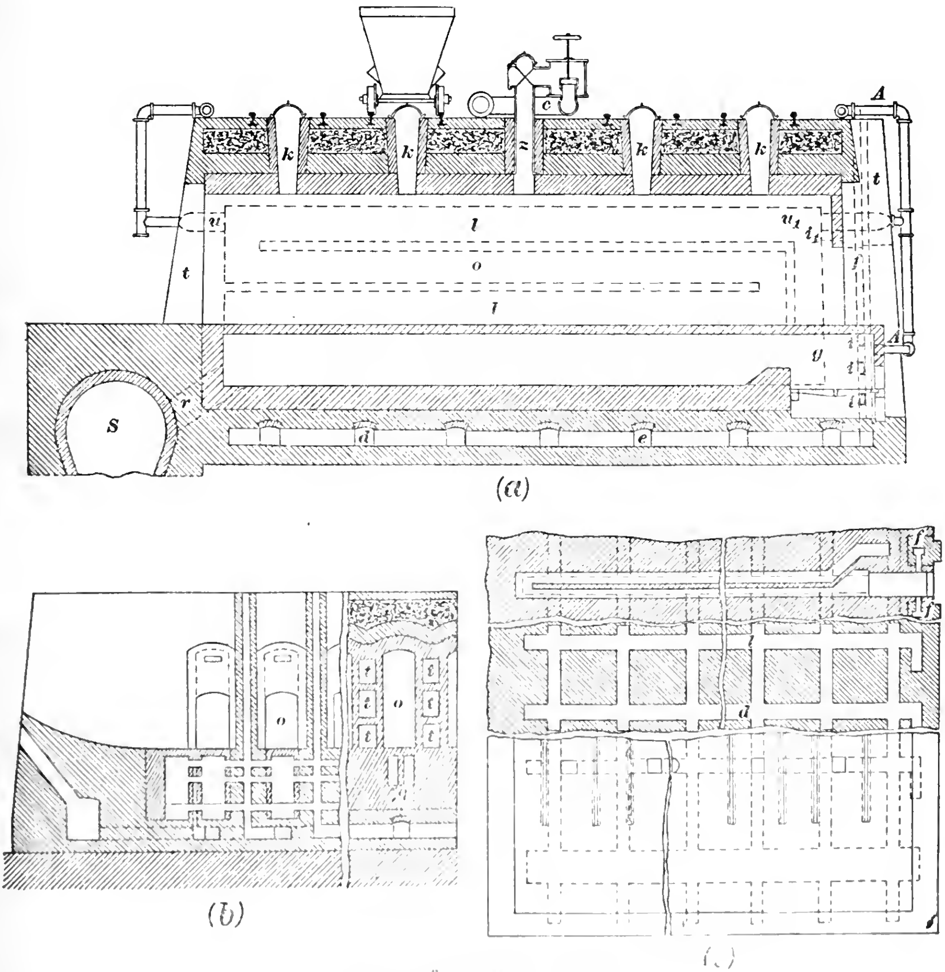


TRANSVERSE SECTION OF AN OTTO HOFFMAN COKE OVEN.

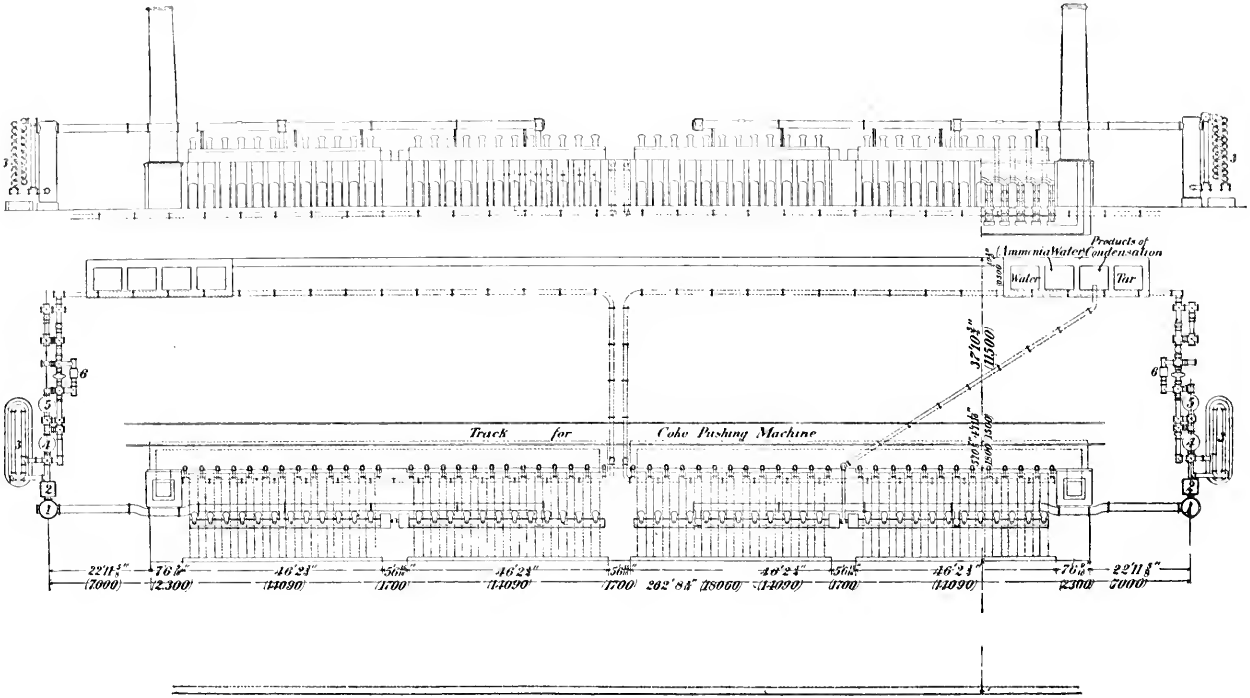
this expansion is followed, at the closing period of coking, by a corresponding amount of contraction, slicing the coke with multiple narrow planes at right angles to the floor of the oven.

It has also been shown, in part, that the confined space in the narrow chamber of the retort oven restrains abnormal expansion and contraction; hence the coke suffers less than from the multiple plane structure of the beehive.

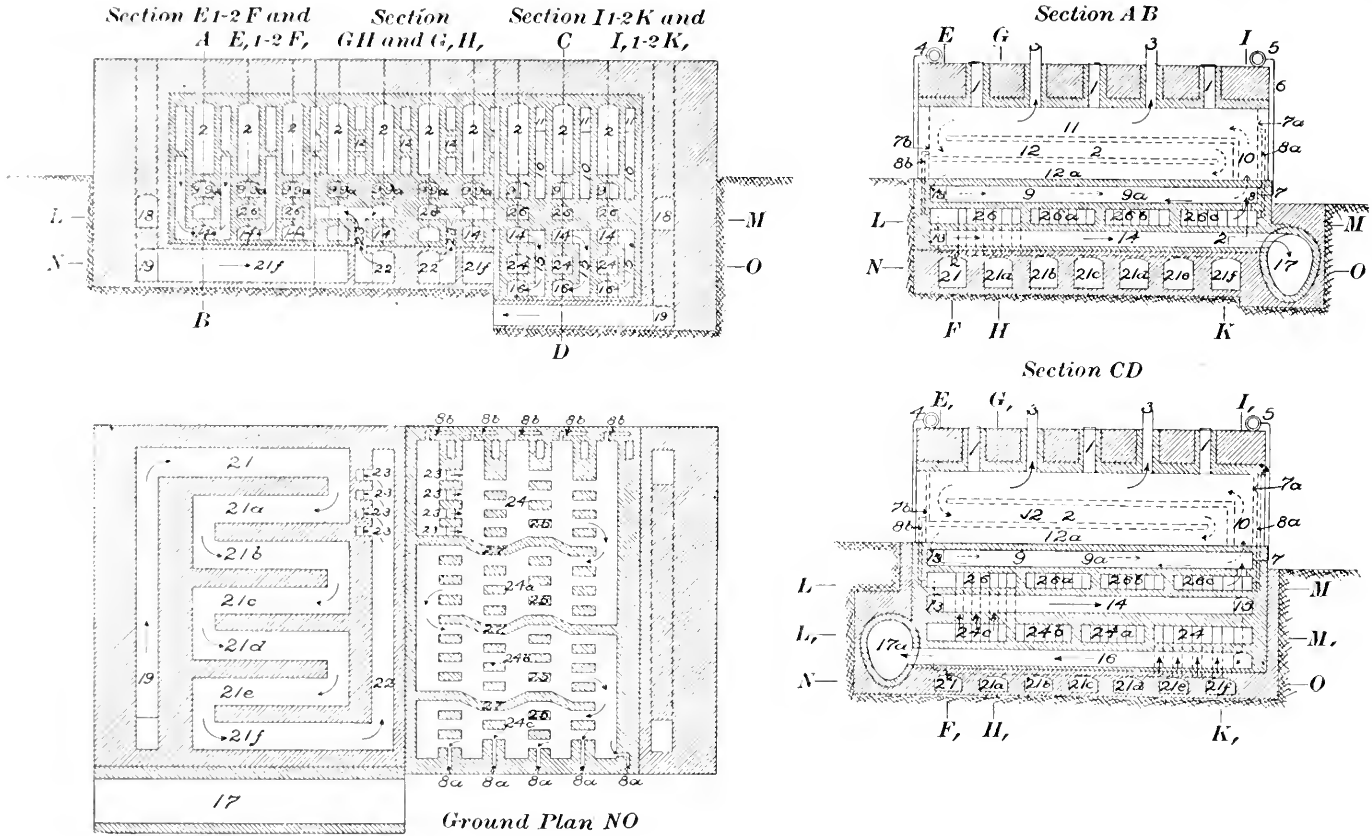
It is, therefore, becoming evident that the retort ovens have their most useful office in coking the extremes of coals,—those poor and rich in bituminous matter.



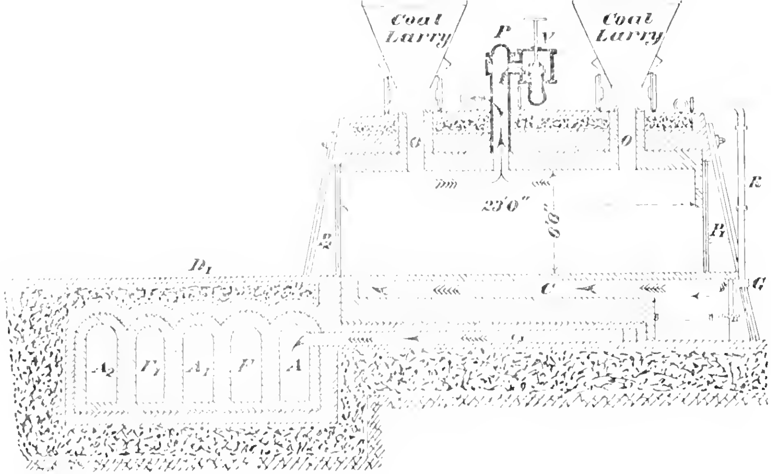
THE A. HÜSSNER COKE OVEN.



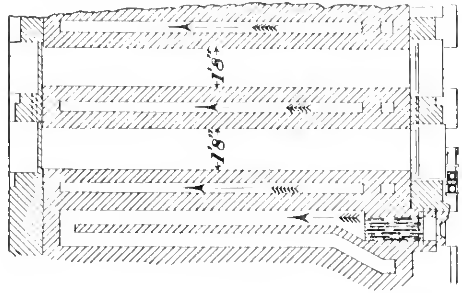
PLAN AND SECTION SHOWING PLANT OF RETORT COKE OVENS—SEIBEL.



THE FESTNER-HOFFMAN COKE OVEN, WITH THE SAVING BY-PRODUCTS AND CONTINUOUS AIR HEATING APPARATUS.

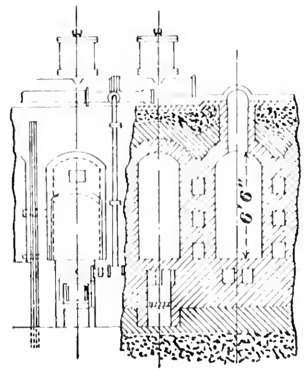


LONGITUDINAL SECTION.



GROUND PLAN.

SECTION SHOWING FLUES BETWEEN OVENS.



CROSS SECTION.

THE SIMON-CARVES COKE OVEN.

The essential elements in the physical and chemical properties of good metallurgical coke are as follows: (1) hardness of body; (2) fully-developed cell structure; (3) purity; (4) uniform quality of coke.

By hardness of body is meant the hardness of the cell walls of the coke, not density of the whole. It has been shown that carbon dioxid attacks and dissolves soft coke in its passage down a blast-furnace stack, reducing the calorific efficiency of the fuel charge and disarranging the regular operations of the furnace. Well-developed cells in the coke secure its rapid combustion, and combine with hardness of body to secure its pre-eminent value as the most vigorous metallurgical fuel. The freedom of the coke from sulphur and ash is an evident requirement; these can be reduced by modern appliances. The uniformity of quality can be governed by the manufacturer, and should receive most careful attention. The following table exhibits, approximately, the work of the three chief fuels in blast-furnace operations:

Kind of fuel.	Proximate analyses.					Size of furnace.	Per cent. iron in ore.	Pounds of fuel to 1 ton of pig iron.	Output per month gross tons.	Relative values.			Locality
	Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.					Economy.	Speed.	Purity.	
Charcoal.	3.50	6.40	87.00	3.00	tr	12′ × 60′	55	1815	3.379	100	100	100	Wisconsin.
Anthracite.	2.50	4.00	87.00	6.00	0.50	17′ × 65′	55	2244	2.698	123	80	97	New Jersey.
Coke.	0.49	0.01	87.46	11.32	0.69	22′ × 90′	59	1737	10.536	96	311	94	E. T'ms'n, Pa.

The following statement establishes the supreme value of coke in blast-furnace operations.

THE CARNEGIE STEEL COMPANY, LIMITED,
GENERAL OFFICES; CARNEGIE BUILDING,
PITTSBURG, PA., February 13, 1896.

Results obtained by the use of coke, from the H. C. Frick Coke Co. in the Edgar Thomson blast-furnaces:

As illustrating the work done, one of these furnaces produced, in one year, 140,000 gross tons of pig iron, with a coke consumption of 1,819 pounds; and, in the year following, 130,200 gross tons, on a coke consumption of 1,798 pounds. Other furnaces have produced, in one month's run, 13,353 gross tons, with a coke consumption of 1,871 pounds and 13,246 gross tons, with a coke consumption of 1,724 pounds per ton of pig.

The above-mentioned results have not been obtained at the expense of quality; for, as a matter of fact, such results can only be obtained from a furnace working under the most perfect conditions.

One furnace at these works has produced, on its present lining, 668,000 gross tons of metal, with an average coke consumption of 1,887 pounds. This includes the high consumption of fuel occasioned by several shut-downs during the past five and a half years, with the resulting period of irregular working subsequent thereto. When the irregularities in a long campaign are considered, these results demonstrate in a very marked manner the integrity of the coke, and can only be accomplished through use of a high-grade coke which is practically uniform throughout each month in the year, —since it is a well-recognized fact that the admixture of good coke with one of inferior quality cannot produce uniform or satisfactory results in a blast furnace.

One feature of the figures given above should be well considered,—*viz.*, the consumption of coke in connection with the large output of iron. It has been demonstrated so thoroughly that, with a small volume of air, and a low output relatively to the cubical capacity, the consumption of coke is much lower than when the furnace is driven. This is necessarily the case, since the long exposure of ore in the furnace permits a very extensive removal of the oxygen by the gases,—little demand being made on the solid carbon in the charge; whereas, with rapid driving, the exposure of ore is much less, and a greater demand is made on the solid carbon, which increases the coke consumption; and, in estimating the value of a furnace fuel, the output per one hundred cubic feet of capacity should invariably be considered.

No reliable records were kept of the annual output of coke in the United States prior to 1880. But up to that time there had been a gradual increase, as shown by the number of coking-plants reported,—beginning in 1850 with four establishments, and closing in 1880 with 186. See table, page 229.

In the following table are shown the statistics of the manufacture of coke in the United States from 1880 to 1894, inclusive:*

STATISTICS OF THE MANUFACTURE OF COKE IN THE UNITED STATES, 1880 TO 1894, INCLUSIVE.

YEARS.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1880....	186	12,372	1,159	5,237,741	3,338,300	$6,631,267	$1.99	63
1881....	197	14,119	1,005	6,546,662	4,113,760	7,725,175	1.88	63
1882....	215	16,356	712	7,577,648	4,793,321	8,462,167	1.77	63
1883 ..	231	18,304	407	8,516,670	5,464,721	8,121,607	1.49	64
1884 .	250	19,557	812	7,951,974	4,873,805	7,242,878	1.49	61
1885 ...	233	20,116	432	8,071,126	5,106,696	7,629,118	1.49	63
1886....	222	22,597	4,154	10,688,972	6,845,369	11,153,366	1.63	64
1887....	270	26,001	3,584	11,859,752	7,611,705	15,321,116	2.01	64
1888....	261	30,059	2,557	12,945,350	8,540,030	12,445,963	1.46	66
1889....	252	34,165	2,115	15,960,973	10,258,022	16,630,301	1.62	64
1890....	253	37,158	1,547	18,005,209	11,508,021	23,215,302	2.02	64
1891 ..	243	40,245	911	16,344,540	10,352,688	20,393,216	1.97	63
1892 .	261	42,002	1,893	18,813,337	12,010,829	23,536,141	1.96	64
1893 ...	258	44,201	717	14,917,146	9,477,580	16,523,714	1.74	63.5
1894 ...	260	44,772	591	*a*14,337,937	9,196,244	*a*12,273,669	1.337	64

a Excluding New York.

The foregoing tables exhibit in a brief, but clear, light the rapid progress of the manufacture of coke from 1880 to 1894. The product of coke for 1883 and 1884 was greatly reduced by the general business depression, which was especially disastrous to the coke consumers,—the iron and steel manufacturers.

* From Joseph D. Weeks's Report to United States Geological Survey.

NUMBER OF COKE OVENS IN THE UNITED STATES ON DECEMBER 31 OF EACH OF THE YEARS FROM 1880 TO 1894

States and Territories.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.
Alabama	316	416	536	767	976	1,075	1,301	1,555	2,475	3,944	4,805	5,068	5,320	5,548	5,551
Colorado	200	267	344	352	409	434	483	532	602	834	916	948	*a* 1,128	*a* 1,154	*a* 1,154
Georgia	140	180	220	264	300	300	300	300	290	300	300	300	300	338	338
Illinois	176	176	304	316	325	320	335	278	221	149	148	25	24	24	24
Indiana	45	45	37	37	37	37	100	119	103	111	101	84	84	94	94
Indian Territory	20	20	20	20	20	40	40	80	80	78	78	80	80	80	80
Kansas	6	15	20	23	23	23	36	39	58	68	68	72	75	75	61
Kentucky	45	45	45	45	45	33	76	98	132	166	175	115	287	283	293
Missouri	0	0	0	0	0	0	0	4	4	9	10	10	10	10	10
Montana	0	0	0	2	5	2	16	27	40	90	140	140	153	153	153
New Mexico	0	0	0	12	70	70	70	70	70	70	70	*b* 0	50	50	50
New York	......	......	......	......	......	......	......	......	......	......	......	......	......	*c* 12	*c* 12
Ohio	616	641	647	682	732	642	560	585	547	462	443	421	436	435	363
Pennsylvania	9,501	10,881	12,424	13,610	14,285	14,553	16,314	18,294	20,381	22,143	23,430	25,324	25,366	25,744	25,824
Tennessee	656	724	861	992	1,105	1,387	1,485	1,560	1,634	1,639	1,664	1,995	1,941	1,942	1,860
Utah	20	20	20	20	20	20	20	0	0	34	80	80	83	83	83
Virginia	0	0	0	200	200	200	350	350	550	550	550	550	594	594	736
Washington	0	0	0	0	0	2	11	30	30	30	30	80	84	84	84
West Virginia	631	689	878	962	1,005	978	1,100	2,080	2,792	3,438	4,060	4,621	5,843	7,354	7,858
Wisconsin	0	0	0	0	0	0	0	0	50	50	70	120	120	120	120
Wyoming	0	0	0	0	0	0	0	0	0	0	20	24	24	24	24
Total	12,372	14,119	16,356	18,304	19,557	20,116	22,597	26,001	30,059	34,165	37,158	40,057	42,002	44,201	44,772

a Includes 36 gas retorts. *b* Coke was made in pits. *c* Semet-Solvay ovens.

But, under all this depression, the coke manufacture has maintained a firm place in the market, increasing from 3,338,300 net tons in 1880 to 12,010,829 net tons in 1892,—a gain in thirteen years of nearly 260 per cent., or an average annual increase of 20 per cent.

The loss from 1892 to 1894, the years of greatest business depression, was nearly 23½ per cent. However, the increased output of 1895 will arrest the downward tendency, and show a large gain.

The following table gives the relative rank of the States and territories in the production of coke in the years 1880 to 1894, both inclusive:

RANK OF THE STATES AND TERRITORIES IN PRODUCTION OF COKE FROM 1880 TO 1894.*

States and Territories.	1880	1881	1882	1883	1884	1885	1886	1887	1888	1889	1890	1891	1892	1893	1894
Pennsylvania	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Alabama	5	5	4	3	2	2	2	4	3	2	2	2	2	2	3
West Virginia	2	2	2	2	3	3	4	2	2	3	3	3	3	3	2
Colorado	7	6	6	5	5	5	5	5	5	5	5	5	4	4	4
Tennessee	3	3	3	4	4	4	3	3	4	4	4	4	5	5	5
Virginia	....	....	..	8	7	7	6	6	6	6	6	6	6	6	6
Georgia	6	7	7	7	6	6	7	8	7	7	7	7	7	7	7
Kentucky	9	10	10	11	12	13	14	12	9	12	11	10	9	8	9
Montana	....	....	....	....	15	15	....	16	12	10	10	11	10	9	12
Ohio	4	4	5	6	8	8	8	7	8	8	8	8	8	10	8
Utah	12	....	13	....	....	....	....	....	....	19	13	14	13	11	11
Wisconsin	....	....	....		....	....	....		18	9	9	9	11	12	18
New York	....	....	....	....	....	....	....	..	....	....	....	....	....	13	10
Kansas	10	9	9	10	11	11	9	10	11	11	12	12	12	14	13
Indian Territory	11	11	11	13	13	12	12	14	15	15	14	13	16	15	19
Washington	....	....	....	....	14	14	15	11	10	17	17	16	15	16	16
Missouri	....	....	....	....	....	....	....	17	17	16	15	15	14	17	20
New Mexico	....	....	12	12	9	9	10	13	14	18	19	20		18	15
Indiana	....		..	....	....	....	13	9	13	14	16	18	17	19	14
Wyoming	....			...	....	....	....	....	....	...		19	....	20	17
Illinois	8	8	8	9	10	10	11	15	16	13	18	17	18	21	21

*From report of J. D. Weeks in United States Geological Survey.

In addition to its use for metallurgical purposes, coke fuel, in the past few years, has found an increasing market in domestic uses. This has been developed by a special preparation of the coke, breaking it to several sizes for use in heating furnaces and stoves, thus enabling it to take the place of anthracite coal, compared with which it gives greater economy and equal efficiency.

The outlook for the expansion of the manufacture of coke is, therefore, assured. This is evident from the large areas of coking-coal scattered over the United States, assuring a wide-spread supply at equitable and moderate cost.

While Pennsylvania, West Virginia, and Alabama are at present the great coke-producers, the table above shows the rapid growth of the coke industry in eighteen other States and territories.

The very great value of coke can be appreciated only in a moderate degree. It is only when we endeavor to contemplate the absence of coke, with the consequent paralyses of the great metal-working industries, that its real importance can be measured.

As the United States inherits, as far as present information shows, about sixty per cent. of the world's coal-supply, with an equally liberal endowment of the ores of iron, it is manifest that, except from man's retarding policy, there can be no interruption to the onward and upward growth of these twin handmaids to the great metal industries, which contribute so largely to the civilization, happiness, progress, and power of our young republic.

NOTE.—The illustrations on pages 216, 218, 220, 222, 223, and 225 are from "A Treatise on the Manufacture of Coke and the Saving of By-Products, with Special Reference to the Methods and Ovens best adapted to the Production of the best Coke from the Various American Coals," by John Fulton, E. M. Published by The Colliery Engineer Co., Scranton, Pa. Price $4.00.

DEVELOPMENT OF ELECTRIC LIGHTING ENGINES.*

By H. Lindley.

THE engines to which this paper refers are what we may call ordinary engines,—*viz.*, having cylinders, pistons, etc.,—and the speed referred to is the speed of rotation of the crank-shaft. Another speed very frequently referred to when speaking of steam engines is that known as piston speed; it should be strictly known as mean or average piston speed; but plain piston speed is enough for our purpose, being a term familiar to you all, and well understood. Now, it is rather a singular thing that this piston speed varies but slightly in the various classes of engines we are now considering. You are just as likely to find a high piston speed in a slow-speed engine as you are in a high-speed one,—if anything, rather more likely; there is then some connection of the inverse kind between rotation speed and piston speed, and that is, of course, the stroke; that is to say, the slow-speed engine has a long stroke, the moderate-speed a shorter stroke, and the high-speed a still shorter stroke. Now, I do not think I need make any attempt to discover and tell you what are the advantages or the objections to slow or high speed; it does not enter into the object of this paper to do so, and no doubt you are as well aware of them as I am, or better.

All I wish to say is that, *per se*, slow speed has certainly obvious objections; and yet, for some reason or other, slow-speed engines are to-day still much used for driving high-speed electric-lighting machinery. Now, I do not think it difficult to find an adequate reason for this, and that is that it is in the nature of a legacy from past ages.

Now, as soon as it became evident that the newly opening-out field of electric lighting was likely to require the services of a large number of small-sized steam engines, nearly every maker of them suddenly awoke to the fact that his particular make of engine was particularly suited for electric-lighting work, and advertised the fact.

The wish, however, was but father to the thought, and, as soon as one of these engines was set to do the work that by calculation it should be equal to doing, and which also by exact calculation it was known to have to do, the crank-pin got hot. An extra large-sized lubricator

*Abstract of a paper read on February 24, 1896, before the Northern Society of Electrical Engineers.

was fitted to the crank-pin, and the engine was advertised as being specially designed and equipped for electric-light work. But still it did not do. Why, then, did engine-builders still persevere till they did produce an engine that would do the work it should do, when all the time there was the slow-speed mill engine waiting and willing to do it? I have said it was too large; so it was, but it would not have been difficult to make small copies of it, and then the thing would have been done. Apart from other reasons, there was, of course, the great question of cost; the slow-speed engine was too dear.

This, then, leads us to the birth of the moderate-speed engine,—that is, the modern moderate-speed one, and one that would really do without flinching the work that calculation showed it capable of doing, and keep on at it for considerable periods of time.

The thing was not so difficult after all, but it wanted doing, and, like many other things of which that may be said, it took time to do. Firstly, the stroke wanted shortening,—that to a certain extent had already been done,—and, secondly, the bearings wanted increasing. Here makers proceeded timidly, and it was some time before a correct proportion was arrived at. And no wonder, when we come to consider the great amount by which such bearings did require increasing. Take as an example an engine with an 8″ cylinder, or say 6 horse-power nominal. This engine now has a crank-pin as large as that used in a 16″ cylinder, or 25 horse-power normal of the slow-speed type not many years ago, or of to-day as made by many makers. The piston speed is about the same in both cases, but the cylinder ratios are as 1:4. True, the smaller cylinder has frequently to stand a rather higher pressure of steam than the older engine, but the difference is not enough to account for all that difference in the size of the crank-pins. What, then, was the cause? Why, as you will guess, the greater number of revolutions; that is the indirect cause, the more direct cause being the tendency to knock out at the higher speeds, and thus displace lubricants. The main bearings have not increased in the same ratio, and for one reason,—*viz.*, that, owing to the speed being higher, the flywheel can be much lighter and smaller.

Lubrication then also became a most important question; the extra large-sized lubricator on the crank-pin had to be abandoned, because it could not be filled while the engine was running, and in its place some continuous method of supplying oil was adopted. A whole crowd of wick or screw adjustment oilers has in most good engines now been replaced by a central oil box with a pipe to each important bearing, and having a slight drop arrangement at the box, so arranged that the supply can be cut off without altering the adjustment.

Another important detail that has led to the success of the modern moderate-speed engine is by no means a new one,—it is only the almost universal adoption of it in this class of engine that is new,—and that is the use of white metal in the bearings. I believe it is not too much to say that the fast-running engines of the present day, including marine and locomotive engines, in addition to those we are now considering, would be almost impossible without the use of white metal. There are many makes on the market, and many good ones, I believe, but, to go no further than the old Babbit metal, the advantages of its use over brass or bronze are many. Not only is it much less ready to take offence at any small particle of dirt that may get into the bearing, and get hot, but it wears longer; and moreover, by use, puts a polish on the pins or journal of the shaft that not only necessitates less oil being used, but must also reduce internal friction in the engine. In heavily-loaded bearings, such as cross-head pins, etc., a quality must be used of sufficient hardness not to pound out.

Then we have another set or class of improvements that were necessary, and have been, or ought to have been, incorporated in the moderate- or high-speed engine of to-day, and I refer to various fastenings about the engine. For example, some years ago when the firm of which I am a member first began to make engines that we fondly hoped were perfect for electric-lighting work, we had the lock-nuts of one of the connecting-rod big end bolts in a small engine jar off whilst working. The lock-nuts were good enough for the old slower speeds, and then you could stop and tighten them if you heard the engine pounding badly through their coming loose, but they would not do for electric lighting. Nothing more serious than a stoppage (quite bad enough I admit) happened in this case, but from that date we abolished lock-nuts throughout the engine (except on main bearings), and used other and more secure devices in their stead.

Slide valves used to be secured on their spindles between lock-nuts in the old days,—a doubly-bad arrangement. No doubt many of you can recollect trying to tighten these at some now distant date with two keys (both too thick) and some pieces broken off the end of a file by way of packing, or with a hammer and chisel, and how the spindle used to spring when you tried to hammer against the nut on it. Apart, however, from the difficulty of tightening the lock-nuts in the valve chest of an engine, they were bad because of the small amount of surface they exposed for driving the valve. Knocking thus took place early at this part, and this tended still more to loosen the nuts. The cross-head and its guide too were in the early days unsatisfactory. In the first place, unless the pin or gudgeon was too small, as it generally was, the cross-head was too heavy, the most frequent construction of forming the fork in the cross-head and fitting the brasses in an eye in the connecting rod not allowing of a very satisfactory job being made of the cross-head if lightness was attempted, unless the pin was made rather short in the bearing. To obtain a wide pin and at the same time a light cross-head, the plan is now almost universally adopted of forging the cross-head on the piston rod, thus saving the heavy boss, and avoiding the risk of the cotter giving out if water were met with in the cylinder, and forking the rod, by which means a wide pin and a light cross-head are obtained.

A word should also be said about pistons ; not that there have been any very radical improvements made in them of late years, but rather that of the types to hand the most suitable should be chosen, and, moreover, the choice should be carefully made.

Cast-iron rings wear very well, if made of good material ; but unfortunately they do not lend themselves, at least in the ordinary form, very well to use with a solid piston body, which is much to be preferred to one made with a junk ring, in an engine running at moderate or high speed. The ordinary pattern of piston, solid if over sixteen inches or so in diameter, or made with a junk ring if less, with two cast-iron rings expanded by an inch coil, answers very well for slow or very moderate speeds, but it is certainly advisable to avoid the screws necessary where a junk ring is used, and also to reduce as much as possible ring friction, which with the above construction is probably always more than necessary.

Another point that deserves attention is the valve. This may be either of the flat or piston type. The flat valve has the advantage of cheapness and steam tightness, but it takes more power to drive than the piston valve, and that is a consideration where automatic expansion by means of a shaft governor is used, as it always should be. It does very well, however, with low pressures of steam, and, if made with a trick port, gives good openings to the cylinder, and that without excessive travel. In the low-pressure cylinder of a compound engine it is advisable to carry the spindle through the valve chest, so as to afford a double bearing for it and to fit a spring between the spindle and the valve, as by this means the annoying clattering present when running non-condensing on light loads is avoided.

Undoubtedly the best construction is a well-fitting solid valve, without packing of any sort. The liners should be most carefully bored out to attain this result, ordinary boring not being good enough unless lapped out afterwards ; and this is not very advisable, as it is impossible to get out all the emery used in lapping. The valve should be ground and polished to a perfect fit, and then, as long as that condition of fit lasts, you have the best valve. But unfortunately that condition is not an everlasting one, and there is, therefore, a great temptation to fit some form of spring packing. The objection to spring packing is that the liner gets worn as much as the rings, and, when it becomes necessary to renew the valve, it is like "putting new wine into old bottles"; they do not go well together.

I have now reviewed most of the points that have required attention at the hand of engineers in adapting the moderate-speed and still most extensively-used engine to the needs of electric-lighting work. I have not, however, entered into the question of governing, beyond suggesting that a shaft governor should be used, altering the angular lead and throw of the eccentric so as to vary the cut-off and compression. I think I ought, however, to give some reason why a shaft governor is to be preferred to one operating a throttle valve; but, before doing so, I might refer to one feature of the throttle-valve governor wherein it is superior to the other, and that is the ease with which its speed may be altered whilst the engine is running. A speeding device for a throttle-valve governor usually takes the form of a supplementary spring attached to some moving portion of the governor operating the valve. When tension is put on this spring, an extra resistance is added to that restraining the opening of the governor balls, and thus more speed is required to get them out, and the engine has to run faster to do so, and *vice versa*. Speeding gear, it is true, can be fitted to a shaft governor, but it is nothing like so simple a matter; on the other hand, the advantages of a shaft governor controlling the cut-off are many and manifest. First, the great objection to a governor belt is entirely removed; this can also be secured in a throttle-valve governor, and in two ways. The governor may either be driven by a pitch chain, or it may be mounted on the shaft of the engine and its motion transmitted to the valve by means of a system of levers.

Then, again, on the mere question of governing,—that is, close regulation of speed,—the shaft governor has the advantage, and for the reason that the compression of the exhaust in the cylinder is varied at the same time that the cut-off is altered.

I was careful just now to say "an engine fitted with a shaft governor and a single valve," and it was necessary to do so, as there is another way of using a shaft governor, and that is with two valves. A main valve is used in this case, driven by a fixed eccentric, set to give the latest cut-off and compression required. The cut-off valve works on the back of the main valve, and its eccentric is loose on the shaft and under control of the shaft-governor, but this eccentric is merely rotated round the shaft to obtain the various points of cut-off,—that is, it has its angular lead only altered, and not its throw. This method of governing, which has for its first disadvantage the multiplication of parts necessary to operate two valves, has also the same disadvantage as the throttling method,—*i. e.*, the fixed compression,—but it has also another special one of its own, and that is, if any steam is admitted at all, it is of high pressure, and, even if it be cut off at the dead center, the clearance will be all filled, and enough steam get in to make the engine run away. Now, just as I said at the commencement of this paper that, *per se*, slow speed is a disadvantage, so I must now say that, *per se*, high speed is a great advantage, and for the simple reason that direct communication with the dynamo is possible, and all other means of transmission are avoided. It is not very likely that any great increase in speed over what at present obtains will be attained,—that is, in engines of the class we are considering, or where there is rubbing contact.

The high-speed engine can no doubt be made very economical, if only on account of its high speed, and the consequent higher temperature of its cylinder walls, but it is more susceptible to derangement from careless use, and, if a breakdown of any part should occur, the results are more disastrous than in a slow-speed engine. Water, in particular, is a source of the greatest danger, and a separator is therefore usually fitted to this class of engine.

There is, however, one point to which I should like to call attention before bringing this paper to a close, and that is that, in addition to the electrical industry having created a demand for a new and improved race of engine attendants,—that is, at any rate, so far as land practice is concerned,—the old easy-going mill-engine tender, with hardly a care to trouble him, has, in central electric-light stations, had to give way to a man who is constantly on the watch lest anything should go wrong, and who is alive to the importance, with others about the station, of maintaining a steady and uninterrupted working of the plant under his charge. Marine engineers knew what this meant better than those in charge of stationary engines; but the advent of high-speed steam and dynamo electric machinery, that must be kept going, has necessitated vastly-increased watchfulness and care from those in charge to what obtained only a few years ago.

ARE BRITISH RAILROADS GOOD INVESTMENTS?

By Thomas F. Woodlock.

ONE of the most remarkable developments of that period of dull times and excessive demand for good investments which followed upon the Baring crisis of 1890 is undoubtedly the enormous advance that has taken place in the prices of all British railway stocks that yield any return at all. This advance really dates from Mr. Goschen's famous conversion of British consols into a 2¾ per cent. stock, which eventually became a 2½ per cent. stock. The first impetus to prices came from the rush of investors, who were confronted with a reduction of interest on their holdings in British funds, and sought to invest their money elsewhere, so as to avoid loss of income. This drove British railway debenture stocks, guaranteed stocks, "preference" stocks,—in fact, all stocks of fixed yield, with priority of claim over "ordinary" stocks,—to what were then considered extremely high prices. As many will remember, it also inaugurated an era of speculation.

When the Baring crisis came, shutting off all channels of foreign investment and severely checking speculation everywhere, the demand for these stocks became more urgent, because the savings of the country had to find investment at home. This inaugurated a period of steady absorption of stocks, not merely those with "priority of claim, but also "ordinary" stocks of the best roads. Certain stocks, —such, for example, as "Brighton A" or "Deferred,"—which were wont to be the speculative footballs of the Stock Exchange, were gradually taken off the market by investors, and the floating supply became smaller and smaller, so that they lost their speculative character to a large extent.

Interrupted only by a severe coal miners' strike in 1893, the process of "breaking records" went on, and stock after stock, especially of the priority class, sold at the highest prices ever known. Most of the leading railroads converted their 4 per cent. debentures into 3 per cent. debentures for the convenience of investors, issuing, of course, nominal capital in compensation for the decreased interest. There was also started, and somewhat extensively practised, a system of "stock splitting," by which a high-priced stock, paying, say, six or seven per cent., was split into a "preferred" and "deferred" stock, each of equal amount with the original. This provided, in place of the cumbrous and high-priced stock, two stocks,—one with a fixed yield, the other with an uncertain yield representing future prospects. Companies were even formed to carry out the splitting process, where the railroads were unwilling to do it themselves.

British railway stocks now enjoy a favor in the eyes of the British investor to an extent which it is difficult for us to conceive. They are looked upon as "gilt-edged" investments, much as we look upon the highest class of municipal or State bonds, and even the "ordinary" stocks, the return on which must necessarily fluctuate from year to year, are bought by investors for their yield. A recent list of prices, showing the yield per cent. to the buyer, gives the following extraordinary results.

British railway debenture stocks—that is, the highest class of security, being a first charge on earnings—sell, on an average, at prices which yield the investor barely 2¾ per cent. Many yield only 2⅝ per cent., and some even less.

British railway "guaranteed" stocks sell on about the same level, yielding the investor about 2¾ per cent. Some yield less.

British railway "preference" stocks, at present prices, yield the investor, on an average, 2⅞ per cent. British railway "ordinary" stocks which pay dividends (and almost all pay something) yield the investor between 3¼ and 3⅜ per cent., or rather less than the fortunate bidders realized from the last United States 4 per cent. loan.

Such prices as these argue an extraordinary confidence on the part of the buyer in the safety of the security and the permanence of the yield. Is this confidence justified by the facts? Are British railroad stocks good investments in the highest sense?

The railroad system of Great Britain is, of course, from our point of view, small. It consists of about 21,000 miles of main track. For the purposes of this article the Irish railroads are included. As might be expected, however, the roads are very costly, and very perfect of their kind, and they carry a very dense traffic, both of freight and passengers. Consequently, they earn a very large amount of money per mile of road. As is shown in the appendix (Table B), the gross earnings per mile of road are about $19,000, the expenses about $10,750, and the net earnings more than $8,000. Without attempting to institute further comparison (which would be very misleading), it may be mentioned that on our railroads gross earnings per mile average about $6,000, operating expenses per mile $4,200, and net earnings per mile $1,800. This gives a fair idea of the relative density of business, although it must be remembered that freight rates in Great Britain are at least twice as high as in this country.

The first thing that strikes one, on investigating the statistics of the railroads, is that in the last few years they have absorbed a very large amount of capital, without a corresponding increase in mileage.

The second thing—even more striking—is that this increase in capital has not produced a proportionate increase in net revenue. The third (necessary consequence of the preceding) is that the average return on British railroad capital shows a tendency to decrease. These are three very important facts bearing on the character of this capital as an investment.

The theory of investment in railroad stocks or bonds seems to demand that the first charge upon earnings shall be such a sum as shall meet all purely operating expenses, and shall maintain and renew the plant, so that at the end of each year it shall be at least as efficient, and, therefore, in at least as good condition, as at the close of the preceding year. If, after these charges are met, the residue shows a tendency to increase, the investment is good. If the tendency be in a contrary direction, the investment is not good.

It seems clear, also, that it is necessary to the justification of fresh capital expenditure upon a railroad that it shall result in proportionately increased net revenue, after operating expenses and maintenance of plant are fully satisfied. Otherwise the expenditure does not pay. Clearly, also, capital expenditure which simply prevents decreased net revenue, or results in a disproportionately small increase in net revenue, is not justifiable, because either it is unproductive altogether, or else it partakes of the nature of "maintenance" expenditure.

Ten years ago British railroads were capitalized at approximately $212,605 per mile (see appendix, Table A); at the end of 1894 they were capitalized for approximately $235,600 per mile. The increase in the ten years was $22,995 per mile, or about 10½ per cent. The increase in gross earnings per mile in the same period was from $17,385 to $19,100, being $1,715 or rather less than 10 per cent. The increase in net earnings, however, was from $8,145 to $8,350, only $205, or about 2⅝ per cent. (see Table B, appendix). Allowing for the nominal increase in capital, resulting from conversions in the period 1885-1894, it is probable that "paid-up" capital per mile increased by at least 5 per cent., and probably more. Yet, with the natural growth of business that would necessarily show itself in a country like Great Britain, net earnings of the railroads have not increased proportionately with the increase in capital.

Reference to Table C in the appendix shows that, as compared with ten years ago (and in a very marked way since 1889), the return per cent. on British railroad capital has decreased. The total amount distributed in 1894 was almost exactly the same as in 1889, but the yield per cent. on the capital was 0.45 less. In the case of "ordinary stock," the return on which is shown separately, the distribution in 1894 almost exactly equalled that of 1888, but the return per cent. on capital in 1894 was nearly ⅞ of 1 per cent. less than in 1888. In a general way, it may be said that capital invested in British railroads in the last ten years has been less productive than capital invested previously; the tendency has been for the yield to diminish. Notwithstanding this, capital as we have seen, has been freely invested. In the ten years 1885-1894 the increase has been $919,114,940. Of this we may deduct, say, $450,000,000 for nominal increase, as a result of conversion and "stock splitting," which leaves $459,000,000 actually paid up. By the issue of this capital the railroads have received in actual cash about $600,000,000, as most of the new capital has been sold at high premiums. It is curious to note that the whole of these dividends distributed on the "ordinary" stocks in the period amount to only $676,000,000, and that the railroads have really borrowed as much in new capital as they have paid in dividends on the ordinary stocks.

Why have they borrowed so much money? It is not for new mileage, because the capitalization per mile has increased by 10 per cent. It is not for productive "improvements and additions," because proportionately increased productiveness is lacking. An addition which does not increase revenue or diminish expenditure is not a proper capital charge, according to the best modern practice in railroads. That which simply tends to *hold* business, and not to *increase* business, is a proper charge against *operating expenses.*

We may measure the efficiency of a steam hammer by the price and frequency of its blows. In like manner we may measure the efficiency of a railroad by the number of train-miles run producing revenue, and the amount of revenue produced by each train-mile. If we spend money constantly on the steam hammer, and find its blows increasing in frequency, but diminishing in force in greater proportion, the net efficiency of that hammer is decreasing, and our capital expenditure thereon is not productive or justifiable. If, in like manner, we spend money on a railroad, and find its revenue train-mileage increasing, but the net revenue per train-mile decreasing in greater proportion, so as to diminish the yield on all the capital invested, clearly our expenditure is not justifiable.

We find these railroads making a smaller return on invested capital year by year; we find them earning less in gross for every revenue train-mile run, and spending more per train-mile. The actual increase in paid-up capitalization per mile of road, discarding the nominal increase for conversions, is about 5 per cent. in ten years. As a result of this, the increase in the number of train-miles run per mile of road is from 14,338 to 15,928, or about 11 per cent. So far, so good. The decrease in gross revenue per train-mile (see Table D, appendix) is only about 0.66 of a cent,—a trifling matter. The operating expenses, however, show an increase of 3 cents per train-mile in the ten years. This is equal to about 5 per cent., and the result is a decrease in the net earnings per train-mile of 4 cents, or about 7¾ per cent. Here is evidently the trouble.

A railroad's operating expenses may be divided into "maintenance" charges and "other" charges. The peculiarity of "maintenance" items of expenditure is that, to a very large extent, they are subject to arbitrary changes from year to year, independent of the volume of business done. A locomotive may be left unrepaired; freight cars may be broken up and not replaced; steel rails, if not in absolutely dangerous condition, may be left another year in track; renewals of ties may beskimped, at a pinch, to svae money temporarily; replacement and renewal of bridges, ballast, etc., can all be deferred, if need be.

Labor and fuel, however, in conducting transportation, cannot be curtailed without curtailing train-mileage, for they are absolutely necessary for the running of trains. These items depend rigidly on the volume of traffic, and must vary almost directly with it. They are "compulsory" items, while we may term the other items of expense "optional" items.

Now, we have to deal with a sharp increase in operating expenditure on the British railroads,—an increase which has practically nullified the gross increase per train-mile, and has greatly decreased the net earnings per train-mile. It is this increase which has reduced the yield on capital, because the increase in gross earnings was proportionately equal to the increase in capital. Had expenses increased only proportionately, the net earnings would have increased proportionately, and capital would not have had to suffer a reduced yield. The increase in gross earnings was, however, obtained only by increasing the train-mileage in a slightly greater proportion, and each train-mile earned slightly less in gross than before. On the other hand, each train-mile was much more expensive than before.

Other things being equal, the 333,000,000 train-miles run by the British railroads in 1894 should have cost slightly less per train-mile than the 275,000,000 train-miles run in 1885, because certain items of expenditure are fixed and do not vary with the train-mile. Yet (according to Table D) each train-mile in 1885 cost 61.8 cents, and in 1894 each train-mile cost 64.8 cents. This cost divided itself into the following items in each year (see Table E):

	1885.	1894.
Maintenance of way	11.0	10.9
Motive power	16.4	18.1
Maintenance equip't	6.1	5.7
Other expenses	28.3	30.1
Total	61.8	64.8

Separating the "optional" expenses from the "compulsory" expenses (according to our classification), we find:

"Optional" decreased	0.5
"Compulsory" increased	3.5
Total increased	3.0

Taking the 1894 figures against the 1889 (for a reason to be explained), we find:

Maintenance of way increased	0.5
Motive power increased	1.5
Repair of cars decreased	0.2
"Other" expenses increased	2.0

or, adopting our own classification:

"Optional" expenses increased	0.3
"Compulsory" expenses increased	3.5

Practically all the increase in expenditure between 1889 and 1894 has been in items which vary directly with the volume of business done, and are not subject to arbitrary increase or decrease. It takes as many men, pounds of coal, pints of oil, and pounds of waste, to run a locomotive, no matter how much the prices of these articles vary. It does not necessarily involve the same amount of work on permanent way, rails, bridges, cars, or other structures, as these expenditures can be deferred, or otherwise met. Examination of expense for "labor," in the case of railroads accounting for 75 per cent. of the total mileage of Great Britain (statistics for all, and for these prior to 1889, not being available), shows that between 1889 and 1894 the following changes occurred in each department of expenses:

In maintenance of way	cost of labor	increased	14	per	cent.
" motive power	"	"	23	"	"
" locomotive renewals (included in "motive power" in previous tables)	"	"	11	"	"
" maintenance of cars	"	"	9	"	"
" traffic department	"	"	19	"	"

Reference to Table A (appendix) shows an increase in mileage between 1889 and 1894 of exactly 5 per cent. The increase in train-miles per mile of road in the same period was 729, or 4.8 per cent. Clearly, therefore, while additional men were taken on, the wages of all must have risen decidedly.

Now, the expenditure on coal and coke, and material for repairs, renewals, and maintenance, was as follows between 1889 and 1894 on the same road :

In maintenance of way	cost of material increased		1.5	per	cent.
" motive power	" coal and coke	"	32	"	"
" locomotive renewals	" material decreased		1	"	"
" maintenance of cars	" "	"	2	"	"

From this it seems that the work done, as represented by cost of actual material used in repairs and renewals of cars and repairs of locomotives, was less in 1894 than in 1889, although it cost more. The cost of fuel increased enormously, in response to a higher price and increased train-mileage. Only the items of renewals and repairs of locomotives and cars show a decrease, but the increase in material used in maintenance of way is very small, and less than the increased mileage would call for.

In a word, the railroads seem to have been compelled to spend so much more money to run their trains that they economized on the repairs and maintenance of their property.

Mileage increased 5 per cent., but material used in repair of permanent way increased only 1.5 per cent., although train-miles increased 4¾ per cent.

The number of locomotives owned by the railroads *increased* 13 per cent. in the period 1889 to 1894, but the material used in their repair *decreased* 1 per cent.

The number of cars owned *increased* about 13 per cent. in the same period, but materials and repairs *decreased* 2 per cent.

Even "labor," the actual cost of which has risen, shows a smaller increase in cost in the repair of equipment than the increase in the amount of equipment.

The meaning of all this is that the increase in expenditure on the British roads, which has been so far the direct cause of the decrease in the yield on capital invested, has evidently been forced upon the railroads, and has been accompanied by no corresponding increase in efficiency. On the contrary, it has itself forced upon the railroads economy in the items of "maintenance, repairs, and renewals," and has resulted in less work being done in these departments.

Either the railroads have been less perfectly maintained than before, or else the money for their maintenance comes from sources other than operating expenses,—*i. e.*, from capital. It is certain that operating expenses have in the last few years been charged with proportionately smaller sums for "maintenance" than in the past.

What are we to conclude from this? We see capital being poured into these roads year after year in never-ending supply; we see the yield per cent. on capital diminishing steadily; we see the ratio of operating expenses to earnings steadily increasing, in spite of smaller expenditures in all maintenance departments: what is the only logical conclusion? Is it not that capital expenditures are doing work that should be done by operating expenses; that "*improvements and additions*" (which the auditors appointed by the stockholders semi-annually insist shall be charged to capital, in accordance with a law that they themselves did not make, but must administer) are, in reality, "*maintenance*" and "*maintenance*" alone, inasmuch as they do not increase net earnings?

Furthermore, must we not conclude that the time cannot be far distant when the ratio of operating expenses will advance further, because absolutely necessary "maintenance" expenditure must be made, which can in no manner be charged to capital? The "optional" expenditures are "optional" only for a time: eventually they become "compulsory." Where will then be the already decreased yield on British railroad securities?

Surely it is time that British railroads begin to think of closing "construction accounts" finally and absolutely, according to the most enlightened American practice. It ought to be the business of stockholders to insist on this, in their own interests, as their dividends are slowly becoming more diluted year by year; in fact, as we saw, "ordinary" dividends are being borrowed by the railroads as fast as they are paid. Until this is done, we can hardly see how British railroads can be called good investments.

APPENDIX.

The following figures are taken in all cases from the British Board of Trade "Blue Books" on the railroads of Great Britain, issued annually. The latest issue covers the calendar year 1894. In turning pounds, shillings, and pence into dollars and cents, the arbitrary, but convenient, rates of £1=$5 and 1d=2 cents have been adopted.

TABLE A.

(Showing the number of miles of main track, the total capitalization, and the capitalization per mile of main track from 1885 to 1894.)

	Miles of road.	Capitalization.	Cap'n per mile.
1885	19,169	$4,079,290,275	$212,605
1886	19,332	4,141,721,270	214,240
1887	19,578	4,229,858,270	216,050
1888	19,812	4,323,479,815	218,225
1889	19,943	4,382,975,530	219,775
1890	20,073	4,487,360,130	223,550
1891	20,191	4,597,125,605	227,680
1892	20,325	4,721,786,600	232,315
1893	20,646	4,856,616,765	235,235
1894	20,908	4,926,436,775	235,650

TABLE B.

(Showing the gross earnings, operating expenses, and net earnings per mile of road for each year from 1885 to 1894.)

	Gross earnings.	Operating expenses.	Net earnings.
1885	$17,385	$9,240	$8,145
1886	17,230	9,080	8,150
1887	17,345	9,110	8,235
1888	17,600	9,180	8,320
1889	18,480	9,670	8,810
1890	19,065	10,350	8,715
1891	19,405	10,760	8,645
1892	19,320	10,835	8,485
1893	18,610	10,620	7,990
1894	19,100	10,750	8,350

TABLE C.

(Showing the present classification of capital of British railroads, and the yield thereon in gross and per cent. for ten years 1885-1894.)

I.—CLASSIFICATION OF CAPITAL, 1894.

"Loans" and debentures	$1,362,757,935
"Preference" and guaranteed	1,764,245,420
"Ordinary" or common	1,800,433,420
	$4,926,436,775

II.—YIELD ON CAPITAL.

	Dividends on ordinary.	Do per cent.	All dividends.	Do per cent.
1885....	$ 61,114,140	4.04	$ 168,341,185	4.13
1886....	60,196,580	3.94	168,965,830	4.08
1887....	64,163,875	4.08	174,522,285	4.13
1888....	68,079,985	4.22	180,143,795	4.17
1889....	76,049,635	4.66	189,263,540	4.32
1890....	74,944,320	4.51	190,054,175	4.24
1891....	72,168,285	4.24	188,658,700	4.10
1892....	69,211,405	3.98	187,805,890	3.98
1893....	62,104,150	3.51	181,724,145	3.74
1894....	68,499,725	3.80	190,549,215	3.87
Total,	$676,532,100		$1,820,028,760	

TABLE D.

(*Showing the gross earnings, operating expenses, and net earnings per "revenue train-mile" for the ten years 1885–1894.*)

Gross per tr. mile.	Op. ex. per tr. mile.	Net per tr. mile.
$1.160	$0.618	$0.542
1.160	0.608	0.552
1.160	0.604	0.556
1.150	0.598	0.552
1.165	0.610	0.555
1.160	0.644	0.516
1.170	0.636	0.534
1.150	0.644	0.516
1.145	0.652	0.493
1.150	0.648	0.502

TABLE E.

(*Showing the classification of operating expenses per train-mile for the years 1885-1894.*)

	Maintenance of way.	Motive power.	Maint. of cars.	Other exp.
1885....	11.0 cents	16.4 cents	6.1 cents	28.3 cents
1886....	10.4 "	16.1 "	6.1 "	28.2 "
1887....	10.3 "	15.9 "	6.1 "	28.1 "
1888....	10.2 "	15.7 "	6.0 "	27.9 "
1889....	10.4 "	16.6 "	5.9 "	28.1 "
1890....	10.7 "	18.2 "	6.0 "	28.7 "
1891....	10.8 "	18.9 "	5.9 "	28.8 "
1892....	10.8 "	18.4 "	5.9 "	29.3 "
1893....	11.1 "	18.3 "	5.8 "	30.0 "
1894....	10.9 "	18.1 "	5.7 "	30.1 "

ELECTRICITY AND THE HORSELESS-CARRIAGE PROBLEM.

By Wm. Baxter, Jr.

THE great interest in automobiles that is being displayed, at the present time, not only in this country, but in all parts of Europe, is strong evidence that the era of the horseless carriage is close at hand. It is a very common belief that inventions come first, and the demand for them follows, as the result of energetic efforts on the part of their promoters. This is true in most cases, but very often the demand exists long before it is satisfied. Inventions, therefore, may be divided into two classes,—those that are due to the stimulus of a long-existing demand, and those that create a demand by the force of their intrinsic merits. Those who develop the first successful inventions of the former class, as a rule, reap a golden harvest; and it is on this account that those engaged in such work display so much activity. Sometimes the demand is not so great as to induce inventive genius to put forth its greatest efforts, and then development goes along slowly, until a conviction is formed in the minds of men that it is about time for the want to be satisfied. Then inventive genius attacks the problem with such determination that success is soon attained. This may be said to be the stage that the automobile problem has reached at the present time.

The problem has remained unsolved, so far; not because in making a self-propelling vehicle there is any difficulty insolvable by well-known methods, but because no one has succeeded in removing the objectionable features that have characterized all such devices

Steam wagons have been made from time to time for the last thirty or forty years,* and many of them were very successful, so far as their ability to run up grades, or attain a high speed, was concerned, and, in point of economy of operation, were far ahead of horses. But, notwithstanding such success, they have not come into use, because their objectionable features overbalanced, by far, their advantages.

For the purpose of propelling the general run of vehicles, it may be safely said that steam will never be made acceptable. It will furnish all the power required for the purpose, and at a very economical rate, but it is dirty, noisy, more or less dangerous, and requires so much attention that it would be almost impracticable for one man to run a steam wagon through the busy streets of a city.

* The earliest historical records of efforts to propel vehicles by steam date back more than one hundred years, but nothing worthy of mention was done previous to 1855 or 1860.

The improvements that have been made in gas and oil engines within the last ten or fifteen years have led many to believe that one or the other might succeed in solving the horseless-carriage problem; but those who have devoted themselves to investigating the possibilities of electricity do not entertain such opinions, and it is proposed to show in this article that electricity, which vanquished all competitors in the street-railway field, can achieve as great success in the propulsion of wagons, bicycles, or any other form of vehicle.

No one can question the ability of oil or gas engines to furnish power sufficient to run a wagon under ordinary conditions, as this fact has been well demonstrated. But the mere ability to furnish the energy required does not constitute a successful solution of the problem. Steam can do this much, but yet has failed to meet the case.

Many attempts were made to solve the street-car problem by the use of steam; but all failed, notwithstanding that some of the best engineering talent of the day grappled with the subject. Gas and oil engines also have been tried in this field, but their success was no greater,—in fact, not as great.

When electricity came into the field and achieved a complete success, the advocates of gas and oil engines put forth their greatest efforts, in the hope that the excitement of the moment, caused by the overwhelming victory of the trolley-car, might enable them to get at least a slight foothold. But their failure was absolute; and, so far as the street-railway field is concerned, oil and gas engines have sunk into oblivion. Now, what is true of street cars ought to be equally true of automobiles, as the only difference between them is that the former run on rails, while the latter do not.

If we look into the history of street railway cars, and also that of self-propelling vehicles, we find that many attempts to meet the requirements in both cases have been made with gas and oil engines, as well as with steam. In the street-car field we find that in no case was the success attained so great as to convince railroad managers that it would be wise to discard their horses; and the success of the vehicles has been sufficient only to convince those interested in such matters that eventually some form of motor will supersede animal power.

Efforts to solve the horseless-carriage problem by the use of steam engines have been made for at least forty years, and by oil and gas engines for fifteen years, if not more. Steam has failed completely. Gas and oil engines have attained a limited success, but their performance has not been such as to awaken any great enthusiasm, although it has served to induce a very general belief that a complete and entirely satisfactory solution of the problem is very near at hand.

In order to be able to determine whether it is probable that this solution will be effected by either gas or oil motors, it will be well to look into the steam engine, and see why it has failed; then we shall be better able to decide as to the probability of removal of its objectionable features by the use of gas or oil engines.

Steam has failed for the following reasons: first, the maximum horizontal effort it is able to impart to the vehicle is limited, and is not much greater than that developed when the engine is working at its normal full load capacity; second, the attention required by the boiler is such that one man cannot very well look after it and also operate the vehicle; third, if the boiler is neglected, the fire will go down, or the water will get too low, necessitating a halt until the proper conditions are restored; fourth, a skilled attendant is required to reduce to a minimum the danger of explosion; fifth, there is more or less danger of setting fire to the vehicle, or to the building in which it is kept; sixth, the steam and hot water that always manage to leak out at one place or another not only are disagreeable, but may damage the wagon or its contents; seventh, the vehicle is dirty, because of the necessity of lubricating the large number of working joints in the mechanism, and emits a disagreeable odor, because the lubricating oil on some parts of the engine becomes very hot; eighth, as the engine cannot be perfectly balanced and must run at a high velocity, its racking effect on the supporting framework is great, necessitating extra strength and weight.

Of all these objections, the most serious are the inability to put forth an extraordinary effort when occasion requires it, the practical impossibility of running the vehicle through crowded streets with one man, the excessive weight and strength of supporting frame, and, finally, the uncleanliness and disagreeable odor.

The inability to largely increase the horizontal effort is a fatal defect, which can be overcome only by using an engine of much greater capacity than would be required for the average work. That this is true will be admitted at once, inasmuch as the horizontal effort, or torque, of the driving-wheels is proportional to the pressure exerted by the steam in the cylinder, and this can be increased above the normal amount only by the difference between the maximum pressure obtained with steam following the piston full stroke and the average pressure when the engine is cutting off or throttling to the extent necessary to develop the maximum working capacity. If the engine capacity is sufficient only to meet the ordinary requirements, it will fail whenever called upon to meet extraordinary obstructions, and, as a result, the vehicle will be frequently stalled. Although the engines are generally made of greater capacity than that required for ordinary purposes, they have, perhaps, never been made large enough to cope with every emergency. It is doubtful if a steam wagon was ever made that did not at some time fail through an inability to put forth a propelling effort sufficient to overcome the obstacles in its path.

We will now consider the oil and gas engines, and see whether they possess advantages over steam that will enable them to overcome the most serious defects just enumerated. In so far as putting forth an extraordinary effort is concerned, they are no better off, as the torque they can develop is dependent on the pressure in the cylinder, and this cannot be increased any more above the normal, in gas or oil engines than in steam, if as much; hence, the only way by which they can meet the requirements of extraordinary cases is by the use of an engine much larger than would be required for ordinary work.

A vehicle propelled by a gas or oil engine can be operated safely by one man, and in this respect they are more desirable than steam. In the matter of weight and strength of supporting frame nothing would be gained, for the same type of mechanism is used, and the racking effect due to the unbalanced condition of the moving parts is just as great, while the additional strain caused by the explosive action of the gas in the cylinder would tend to increase the strain, and therefore call for even greater strength. So far as cleanliness goes, nothing could be gained, and, as to unpleasant odors, gas and oil engines would prove more objectionable in the end than steam. The danger of boiler explosions would be removed, but the danger of gas and gasoline explosions would, undoubtedly, fully offset this gain. The danger of fire would, if anything, be increased. The only real advantage, therefore, is that only one man would be required to run the vehicle.

The objections peculiar to most types of gas and oil engines are that they will not start unaided, and that they require an electric battery or some equivalent device to furnish the spark or flame by which the gas is exploded. Some of these engines are made self starting, and this is really the only type that would be at all suitable for vehicles; but it will have to be thoroughly demonstrated that they can start up under a heavy load, on a steep grade, before their success in this direction can be accepted without question.

In many cases the inability of gas and steam engines to put forth an extraordinary effort when required has been overcome by the use of gearing, whereby the ratio between velocity of piston and vehicle could be greatly increased, so as to increase the horizontal effort by a reduction in speed. But such an expedient serves only to increase the complication of mechanism, and, on account of the greater liability of the vehicle to get out of order, cannot be regarded as a more satisfactory way out of the difficulty than that of using a larger engine.

Great claims have been made as to the lightness of some gasoline motors; but, as they are constructed on the same general principles as all other gas or gasoline engines, it is not apparent why they should be lighter. All engines of this class, as well as steam engines, consist of one or more cylinders with their pistons, connecting-rods, cranks, etc. As the physical properties of matter are such that they cannot be changed by the magic wand of any designer, no matter how skilful, it is difficult to believe that any one can obtain results in the way of lightness of construction that are so far beyond the reach of all others.

It is claimed for some of the gasoline engines made for automobiles that they weigh fifty or less pounds, and develop two or three horse power; however, this is not so very wonderful, because less than half this weight is claimed for a steam engine of equal capacity.

Perhaps it is possible to construct engines of this extreme lightness that will run long enough for the purposes of an exhibition test, but no engineer of repute would be willing to say that such a machine could stand the strain of constant usage.

Now let us consider what the electric motor can do in the way of removing the objections pointed out. The first point in its favor is that it cannot be stalled by any resistance, within practical limits, that may be opposed to it. A one-h. p. motor which would propel a vehicle at a speed of one thousand feet per minute against a resistance of, say, thirty-three pounds could instantly put forth an effort great enough to overcome a resistance of three or four hundred pounds, if the occasion required it. It is true that under so enormous a strain it would soon give way from being over-heated; but, in any case that is at all likely to be met in actual running, such an effort would be required only for a few seconds. Under a strain of a hundred, or a hundred and fifty, pounds, such a motor would run for several minutes, and this would be an increase of capacity simply impossible with gas or gasoline engines, without resorting to gearing. When in motion, the speed of the vehicle could be increased or reduced as desired. And all this could be accomplished by a machine that, from a mechanical standpoint. is the embodiment of simplicity. It is not only simple, but very durable, and it has but one moving part. It can be made exceedingly light without in any way impairing its strength. It is very compact, requires no attention, does not smell, will not explode, is always ready to start, and can be controlled with much greater certainty than any other form of motor known.

The only thing that stands in the way of the complete solution of this automobile problem by the electric motor is the method of obtaining the electric energy with which to operate it. The only way in which this part of the problem can be solved is by the use of storage batteries. and these devices have not given results, in the past, of such a character as to inspire confidence in their ability to meet the requirements. But at the present time they are not so far from perfect as the great majority of electricians believe. The storage battery in its early days was the victim of sensational writers, who, according to their custom, claimed for it results that were physically impossible. Their efforts were assisted by the attempts of ill-advised inventors to compete with the trolley system, in the face of the fact that their inventions were defective in the direction in which the greatest perfection was necessary, in order to achieve anything like success in that field.

The greatest defect in storage batteries generally is inability to withstand, without undue deterioration, a rapid rate of charge and discharge, particularly the latter. If a battery cannot be discharged in less than ten hours, without over-straining, it is evident that a car or carriage would have to carry as many cells as would be required to furnish the energy used in that time: but, if the time of discharge can be reduced to one hour, the number, and therefore the weight, of cells can be reduced to one tenth.

The storage-battery field, like every other profitable line of scientific inquiry, has been invaded by charlatans, by ignorant dreamers who hoped to hit upon the right thing by luck, and by a few men who are masters of the subject. Those of the latter class have sought to obtain better results by reducing the time of charging and discharging, by reducing the deterioration, the weight, and the cost of construction either of the whole battery or of the parts that deteriorate.

The time of discharge of any battery can be reduced, but by such reduction the deterioration is very greatly increased. What is desired is to reduce the time of discharge without increasing the deterioration, and, if possible, even decrease the deterioration under such conditions. By increasing the rate of discharge, and by reducing the weight per unit of energy delivered, the total weight of battery required to propel a car or carriage can be greatly reduced. The average weight of the batteries now on the market is about one hundred and forty pounds per h.-p. hour, and the economical rate of discharge at which deterioration is not excessive is ten hours: therefore, a vehicle requiring two h. p. would have to carry 2,800 pounds of battery cells, and would be able to run for ten hours. If the battery could discharge in two hours, and weighed seventy pounds per h.-p. hour, the weight would be reduced to 280 pounds, or 560 pounds for four hours' actual running.

There are no such storage batteries on the market at the present time, but such results are within the limits of possibility, and some of the most able workers in this field have already obtained even better results. The weight of material that undergoes chemical change in a storage battery is about eleven pounds per h.-p. hour: the excess above that amount represents the weight of the cells, the supports for the plates, the electrolytic fluid, and the unused active material. A reduction of the weight, therefore, even to thirty or thirty-five pounds per h.-p. hour, is possible, although there is not much probability of obtaining such results, at least in the near future. But the possibilities already in sight are sufficient to insure the success of the storage battery in the propulsion of vehicles.

An objection may be raised to the use of storage batteries on account of the difficulty of having them recharged, especially if they are only of sufficient capacity to run a wagon twenty or twenty-five miles. This objection would be a fatal one, as matters now stand ; but, when it has been demonstrated that they can be used with perfect success in this line of work, ways will promptly be devised whereby discharged batteries may be exchanged for charged ones, at convenient places, and with but a few minutes' delay.

The general impression at present appears to be that self propelling vehicles will be used for pleasure purposes, and, therefore, that they should be able to take a run out into the country of, say, fifty miles and return. For this kind of service it is evident that electric automobiles would be useless, at least for years to come. But this is not the legitimate field for such conveyances ; their sphere of usefulness will be found to be in the business world as express and parcel-delivery wagons, hacks, drays, etc. ; and for this class of work electric wagons, provided with storage batteries, as light and durable as those we expect to see in actual service before long, would be successful in the highest degree.

It may be claimed that the cost of operating an electric wagon would be greater than the cost of operating one run by either gasoline or gas, and this would be true if the mere cost of energy were considered ; but, if to the cost of oil or gas is added the increase in insurance charges on the vehicles and the premises in which they are housed, and also the difference in the cost of repairs to the entire outfit, it will be found that the scale will turn in favor of electricity. But the most important point in favor of electricity is that it is always ready, and able to cope with any emergency. For example, a wagon weighing, say, two tons with load would require a horizontal effort of about sixty pounds to keep it in motion on a level, well-paved street ; but, if the wheels should drop into a hole in a poorly-paved street, or become stuck in deep mud, an effort of several hundred pounds would be required to extricate it. In such cases the electric motor would be found equal to the occasion, as even a two-h. p. motor would be able to put forth a momentary effort of seven or eight hundred pounds. Therefore, such a thing as stalling an electric wagon would be out of the question, and this cannot be said of any other motor.

POINTS IN THE SELECTION OF STEAM ENGINES.

By W. H. Wakeman.

A GREAT many engines are manufactured each year, and many of them, especially those of small and medium power, are purchased by men who are not judges of machinery. In purchasing an engine one of the most difficult points to settle is the size. This will surprise those who think that, if they wish to erect a mill requiring forty horse power, they need only buy a forty-horse-power engine. There are several things that should enter into the calculation, which they neglect, often because they know nothing about them. Especially is this true where engines are purchased to drive wood-working machines.

It is true that a horse power is a fixed quantity, and, as such, a perfectly satisfactory standard for reference; but there are different ways of designing an engine for a given power, and, as competition in this line of work as well as in others, is very sharp, some builders take advantage of every possible chance to give their engine a high rating, not always in the interest of the purchaser.

For illustration, suppose that two engine builders manufacture engines having cylinders of the same size, and that their catalogues call for the same rate of speed: we may yet find that one is rated much higher than the other. Three factors are used in calculating the power of an engine,—*viz.*, area of piston, speed of piston, and mean effective pressure; but, as the two first mentioned are the same in the assumed case, the latter alone becomes the variable factor. In this case the builder who rates his engine the higher may have calculated on a very high boiler pressure; or, with a somewhat lower boiler pressure, he may have based his calculation on a longer point of cut-off, which will give so high a terminal pressure that the engine cannot be called an economical one, because much of the steam passing through it is wasted. This man will frequently get the order for the new engine, as he will agree to furnish a greater power for the same price.

An engine whose piston is twenty inches in diameter, with a stroke of forty-two inches, running at seventy revolutions per minute, is a convenient size for comparison. If we take the mean effective pressure at forty pounds, then we have $\frac{314 \times 490 \times 40}{33000} = 186.5$ horse power. This mean effective pressure is calculated on a basis of eighty pounds' gage pressure on the boilers, or ninety-five pounds' absolute pressure, and a cut-off at one-quarter stroke. The terminal pressure will then be $95 \div 4 = 23.5$ pounds, or 8.5 pounds by the gage, and it certainly should not be any higher than this for economy; some engineers would claim that it should be less than this. The point is that some engine-builders catalogue such an engine as having two hundred and fifty horse power. The mean effective pressure to develop this power can be determined by the following formula:

$$\frac{H.P.\ 33000}{A\ S} = M.\ E.\ P.$$

in which $H.\ P.$ = horse power developed, A = area of piston, S = speed in feet per minute, and $M.\ E.\ P.$ = mean effective pressure. Applying the formula, we have $\frac{250 \times 33000}{314 \times 490} = 53.6$, or, say, 54 pounds' mean effective pressure required for a development of the power named. Now, to get this mean effective pressure with eighty pounds' boiler pressure, the cut-off must be lengthened to nearly four-tenths of the stroke, making the expansion ratio 2.75 and the terminal pressure thirty-five pounds absolute, or 20 pounds by the gage, which is too high for good results. In order to cut off at one-quarter stroke, and still get a mean effective pressure of 54 pounds,—which we must have if we are to develop two hundred and fifty horse power with this engine,—the boiler pressure must be raised to one hundred pounds by the gage. If the boilers will stand this pressure, the engine may be used economically; but, where one firm of engine-builders will furnish an engine of one hundred and eighty-six horse power for a given price, and another will furnish one of two hundred and fifty horse power for the same price, to the uninitiated there seems to be a vast difference in favor of the latter. Yet on investigation we find that the cylinders are of exactly the same size, and it is quite possible that the company agreeing to furnish the greater power for the same money will even hen make the larger profit by putting in less stock, doing a cheaper grade of work, and giving the machine an inferior finish. No wrenches will come with this engine; the purchaser will have to buy a throttle valve; and it will be noted that the bottom of the frame and the outboard bearing are not planed off so as to rest solidly on the foundation, but are just as they came from the foundry. In setting the engine, it must be blocked up level and filled in with sulphur between the iron and the foundation, which is not the best method, although many engines are still so set.

Again, a steam-user desiring a new engine may write to several builders asking for prices on a two-hundred-horse-power engine, and will be surprised at the prices respectively quoted by the manufacturers. Further investigation shows that the party asking the higher price expects to furnish a twenty-by-forty-eight engine, running at seventy revolutions per minute,—which is not unreasonable,—while another bidder expects to furnish a sixteen-by-thirty-six engine running at one hundred and twenty-five revolutions per minute. This calls for a mean effective pressure of forty-five pounds, which, of course, can be secured ; but note the difference in speed.

I am in charge of a slow-speed engine ; wishing to be absent for half a day, I engaged to run it for me a friend who had been employed on high-speed engines. Looking at the sight-feed oil-cups on the guides and wrist-pin, he asked how long the oil in them would last, to which I replied that at night they would be something less than half full. "Where I have been employed," said he, "they would last about twenty minutes." It is true that his engines were running much faster ; but, with slight modification, this illustration will do very well here. High speed means more friction, and that means a larger expenditure of oil. It has been claimed that high speed results in economy of steam ; while this may be true when the machine is in perfect order, the increased friction soon causes leaks in the valves and piston. High speeds are not an unqualified success, and will never be universally adopted.

Let us now give some attention to the power required to run machinery. Assume, for purposes of illustration, wood-working machinery consisting of matcher, surfacer, rip saw, etc. We have been informed by their manufacturers that these machines require a certain amount of power ; but the amount stated appears surprisingly small. When we come to use these machines, we find that they take much more than the estimate calls for. Shall we claim that their builders were dishonest ? Not at all. No doubt these machines could be run with the stated amount of power, but only under the best possible conditions. The knives of the matcher and the surfacer must be sharp, the lumber clean, and the cut light. Why should it require much more power to drive them ? Because the service in the mill is much heavier. Perhaps poorly-sawed lumber must be dressed, the cut being from ⅛ to ¾ inch. Such was not the sort of work for which the power-rating was made. Another load of lumber comes in that has perhaps been unsheltered from storms and is partially covered with ice. The feed-rolls slip, the boards will not feed in, and the operator puts shavings on the boards and his own weight on the feed-roll levers, and thus makes a little progress ; but the power required will be at least twenty-five per cent. greater than that needed under favorable conditions. After a time, the knives get dull ; but there are a few hundred feet more to be dressed, and after that there are some nice dry boards to be planed, so that it is not considered good policy to grind the knives until the rough job is finished ; rosin is put on the belts, and at last the work is done. If no more power is provided than is needed under favorable conditions, the engine will be running at about one-half speed, and the product of the mill will be reduced accordingly.

The same reasoning applies to a circular saw ; when it is sharp and in good order, it needs but little power, but, after its teeth begin to get dull, and before it will pay to sharpen it, much more power is needed to drive it. Almost every other kind of machinery is, in a greater or less degree, subject to variable conditions,— a fact which indicates that it is always wise to have an abundance of power.

Another important thing to be considered is whether more machinery will be added, thus calling for more power than was needed at first ; if this seems probable, provision should be made for it.

After this article was begun, the master mechanic of a large manufacturing establishment mentioned to the writer that, when his engine was first put in, about two years ago, indicator diagrams taken from it showed that it was developing two hundred and fifty-nine horse power, while diagrams taken within a month showed five hundred and ninety-one horse power; and still more is needed. Steam is supplied by boilers of various ages and on different conditions ; and, as one of the oldest is not considered safe at the pressure required to run the engine (90 pounds), it has been cut out, and, at a lower pressure, furnishes steam for other purposes. This puts more work on those that are left ; and, as more power will be needed in a short time, the old boilers are to be taken out, and new ones put in that can safely carry 125 pounds' pressure. It is not considered safe to further increase the speed of the engine. This is probably an extreme case, but it shows the necessity of anticipating and providing for increase of power. Such provision may be made by estimating the capacity of the engine with a short cut-off, and using boilers that will, with from ten to twenty pounds less than they may safely carry, deliver the power at first needed. The speed of the engine may be lower than its safe limit, and, when more power is required, the point of cut-off will be lengthened automatically. When an economical limit has been reached, the boiler pressure may be increased to the safe limit, and, when this will not supply the power needed, the speed of the engine may be increased, the main pulley taken off, and a larger one put on, so that the speed of the jack shaft will remain constant. If the engine has been run as a non-condensing engine, an independent condensing apparatus may be added, —provided water is available,—which will remove some of the useless work, and enable it to do more useful work.

In some cases it is advisable to commence with a single cylinder, making provision for another by having the crank shaft fitted for a crank on the other end of it; when much more power is needed, the other cylinder may be added. This may be made much larger than the first cylinder, thus making a compound engine of it, or it may be made of the same size, thus making it a double engine.

In these days of high pressures and fast speeds, it is very necessary that an abundance of material should be used, in order to prevent undue springing of the parts, which, if it occur, will cause great friction, excessive wear, and frequent failures. The attention of prospective purchasers should be directed to the fact that some engines are not made strong enough for the work that they are intended to do. The frames of some of the long-stroke engines are made without central support, and so light that they spring downward in the middle at every revolution of the engine. There can be no excuse for such defects.

The crank shaft of a certain large engine in the city of New York was made so light that, when the weight of the fly-wheel was put upon it, there was a deflection of about one-eighth of an inch at the center. In consequence of such defects the weight is very unevenly distributed on the bearings, nearly the whole of it being thrown upon their inner edges, thus greatly increasing the liability of the shaft to fracture. The purchasers drove a very sharp bargain with the builders, who are located in a western city, and who finally made a price less than nearer builders: but in this, as in other cases, the purchasers got what they paid for, and nothing more. It is not good business policy to pay an exorbitant price for an engine, but it is good business policy to pay a fair price for value received. The engine in question would develop the power called for by contract, but only on a basis that permitted no allowance for variations in boiler pressure: at no time was power developed on an economical basis.

The builders of medium- and large-sized engines should be required to guarantee a certain duty for their machines, as builders of pumping engines are required to give guarantees. It is true that these guarantees would not read alike: while the pumping engine is usually guaranteed to do a certain number of foot-pounds for one hundred pounds of coal burned under the boilers, or for one thousand pounds of steam passing through the engine, the factory engine is guaranteed to develop a horse power with the consumption of a certain number of pounds of steam per hour: but this amounts to the same thing in the end. Why so little attention is given to this matter may be partially explained by the fact that in some cases the desire for getting an engine at the lowest possible first cost is the controlling motive.

Suppose that one six-hundred-horse-power engine develops a horse power with thirteen pounds of steam per hour, while another requires fifteen. Here is a difference of but two pounds per horse power per hour, or one thousand two hundred pounds total per hour. Even if we have boilers that will evaporate ten pounds of water with one pound of coal, this means a difference of one hundred and twenty pounds of coal per hour, or one thousand two hundred pounds per day, making one hundred and eighty tons per year, which, at $3.50 per ton, amounts to $630.

Although an engine that makes good a builder's guarantee is very desirable, especially if a high duty is warranted, yet there are other things to be taken into consideration along this line; for an engine that is very economical when new may be wasteful of steam after a few years, owing to poor design or imperfect workmanship. This is a point that can be settled only by careful observation of the behavior of different types of engines after years of service. Upon this point the advice of an honest, competent consulting engineer is valuable.

It was formerly claimed by several engine-builders that the plain, flat slide-valve was superior to all others, because, as both valve and seat were flat, the longer it was run, the tighter it would get. I have not seen this statement in any catalogue for some time, and consequently believe that the theory has been exploded. When the power that moves a slide-valve is applied on a plane above the seat, the valve will wear more at the ends than in the middle, and hence become leaky and wasteful of steam. One method employed to prevent this is the use of a pressure plate to hold the valve to its seat and yet allow it to slide. It is possible to so adjust a plate that it will do this; but such an attachment requires a very close adjustment,—much too fine and close for what might be called "rough-and-tumble use." The flat valve can easily be planed off, filed, and scraped to a fit, and its seat may also be so treated: but at the same time we should not lose sight of the fact that the valve-seats of Corliss engines, and of some other types, may be bored out with a good boring bar, and the valves turned up in any lathe that is worthy of the name.

The guides are a very important part of an engine. There are three classes,—namely, the flat, the round, and the V-shaped. Flat guides are mentioned first, because they possess several points of merit. They are easy to keep oiled, because the oil does not gravitate towards any particular point. If they are made long enough to project beyond the cross-head at each end of the stroke, as they always should be, the oil will remain upon them at these points, and, as the engine revolves, the cross-head will come in contact with this oil and draw it back upon the guides, as may be easily noted, especially in the case of a slow-speed engine, where all of the movements may be followed by the eye. Where this form is adopted, the cross-head may be brought into line with the cylinder easily and accurately, and any departure from truth may be detected at once and remedied. In order to do this, the guides should be made in separate pieces, and bolted on the frame, so that they may be taken off and planed smooth, when worn or scored. When made in this way, the cross-head may be made of iron also, or of iron lined with brass, thus insuring great durability; and, if the iron cross-head ever does run dry and score the guides, it is an easy matter to repair the damage. The durability thus secured more than offsets the liability to abrasion.

In the case of guides that are bored out in line with the cylinder, there is less liability that the cross-head will bind on the guides through imperfect alignment of other parts; but, at the same time, the guides can be more easily thrown out of their proper course than any other kind or form. Where the cross-head is made wholly of cast-iron, and runs on cast-iron guides bored out, both parts will last for many years without excessive wear, provided they are always well lubricated. I have seen guides of this type that had been in use for two years, on which the tool-marks were still visible, showing that the wear was unworthy of mention; but, if such guides are ever allowed to become partially dry, they commence to cut without warning, and the whole surface is ruined at short notice. One trouble with them is that the oil put on them gravitates toward the lowest point and tends to leave the high parts without lubrication.

The V-shaped guides hold a cross-head rigidly in place,—a fact which is almost their only recommendation. As frequently made for Corliss engines, these guides are cast in one piece with the frame, and the cross-head shoes are lined with Babbitt metal; consequently the guides are seldom found to be cut or scored, for the Babbitt metal will melt out, if neglected too long. The redeeming quality with this arrangement is that the Babbitt metal may be easily replaced. As a rule, the upper and lower cross-head shoes are interchangeable, so that, with an engine running "over" when the lower one is damaged or worn out, the upper one may be put in its place for a time. This form of guide needs more lubrication than any other kind, for all oil placed on the upper part of the V rapidly finds its way to the bottom, leaving the higher parts dry.

There are two general plans for putting a wrist-pin into the cross-head; one is to cast it in, thus making it solid with the cross-head, and the other is to bore a hole through the cross-head, turn up the pin, and drive it in. In the former case, after the engine has been run for several years and the pin is worn out of round, it is a difficult matter to repair it, without special machinery. In the latter case, the pin may, in a lathe, be made as round as it ever was. The objection to this arrangement is that sooner or later wrist-pin boxes will be accidentally keyed up tighter than they should be, with the result that the pin, being in a round hole, is loosened in the cross-head. No wrist-pin should be accepted, unless it is either cast in, or solidly keyed into, the cross-head at both ends of the pin.

If a piston rod were always perfectly in line, and would never wear out of truth, it would be a much more simple matter to provide stuffing box packing. Under existing conditions we must have packing of various kinds to suit different cases. The use of fibrous packing concerns the economical operation of a plant more than it does the selection of the engine; but, in passing, it may be said that metallic packing is preferable. It may seem rather expensive at first, but it pays in the end by saving in the cost of soft packing, and by obviating unnecessary wear. For an engine of which I once had charge, which was fitted with metallic packing for the rod, an arbor was turned the exact size of the rod, and the packing nicely fitted to it. After the rod had been in use for nearly five years, a comparison of its size with that of the arbor showed that the rod was smaller than the arbor, but not more than $\frac{1}{100}$ inch. Metallic piston-rod packing is a paying investment, and it is wise to specify it when the engine is ordered. Every engine should have a properly-designed and well-built fly-wheel. When fly-wheels burst, they are capable of doing great damage to life, limb, and property. A fly-wheel should have metal enough in the rim not only to make it stiff enough for every-day use, but also to prevent it from springing outward between the arms, for it has been demonstrated that this action does take place at high velocities. The distance between the arms at the rim should not be excessive. No inflexible rules covering every set of conditions can be given, but one point must not be overlooked,—namely, the speed of the rim; this should never exceed 4,800 feet per minute, or 80 feet per second, for any form of cast-iron wheel. Although some wheels exceed this safe limit, it is better to be on the safe side. If the governor fails to work properly for a few seconds only, the safe limit of speed is soon passed. Every engine should have a stop motion of some kind on it, so that, if the governor-belt breaks or runs off from its pulleys, the engine cannot run away. The too-frequent fly-wheel failures have also demonstrated that provision for automatically shutting off steam when regular speed is exceeded and the governor-belt is in place should be supplied. I have thus presented the principal points to be considered by those who contemplate purchasing engines, and which practice and observation have shown to be essential to satisfactory results. Their observance will aid in preventing unprofitable investments and subsequent annoyance.

MODERN MACHINE-SHOP ECONOMICS.

By Horace L. Arnold.

II.—PRIME REQUISITES OF SHOP CONSTRUCTION.

THE space given to the following consideration of machine-shop construction not permitting detail, it will be devoted to a limited survey of good or late practice with a view to determining the general form and arrangement of shop-buildings in which work can be most cheaply built,—that is, in which work can be built with the least expenditure of effort on the part of managers, superintendents, foremen, and workmen.

The requirements of a machine-shop building are sufficient floor-area, protection from the weather, abundant and uniform lighting, and such general arrangement and appliances as shall involve the least transportation of work in progress and effect necessary handling in the cheapest manner. The following are the essentials.

For the workmen, ventilation, sanitation, avoidance of unproductive travel and of floor spaces not at all times open to observation, and an individual space wholly under control of the workman, where he can store his street clothes and other personal effects; intimately connected with this individual space there should be also individual wash-basins, although the most advanced American machine shop so far observed furnishes in a general wash-room one basin for two workmen. The Brown & Sharpe vise bench leg provides for individual wash-buckets for workmen, which is in many ways an excellent arrangement, but the washing arrangements and clothes lockers should unquestionably be close together, and should not be on the shop floor, because of the labor and annoyance caused by filling and emptying wash-buckets, and the want of room on the work-floor for workmen's clothes closets or lockers.

For the officials, there should be a separate space in each department, and for many of the officers a separate room for each individual; all of the offices should be connected by the shortest line of travel, which should not pass through any individual or departmental territory. Most men intent on one pursuit or problem are at their best in solitude, and this solitude should not be broken except when the individual's attention is demanded,—certainly not by the passage through individual territory of those seeking some other objective point. After the possibility of official segregation, or solitude, comes the very important possibility of speedy personal official communication with any place or individual in the establishment, and personal official observation of any department of the works. The rule of solitude for master is reversed for man, unless some system can be devised to make each workman as wholly earnest in his labor as is his superior. In all cases of day-wage every man should be constantly under the eye of many others, and should be perfectly aware that every act of his working hours may be seen by his paymaster. Hence every part of the work-floors of the shop should be exposed to view from the office-floor with the least possible official travel. None of these conditions can be secured with the many-floored shop structure in any form of parallelogram, and late shop structures show a steady departure from this form of machine-shop building.

Colt's Armory, of Hartford, Conn., which was finished in 1855, forty-one years ago, is one of the best examples of a multi-floored machine shop. This building is in the H-form, five hundred feet long in each member, and having wings extending from the H-cross-bar; the front has four floors, the rear and cross-bar have three floors, and the side wings have, I think, one, two, and three floors. The business offices are in a detached building shown at the left of the engraving, connected to the north end of the front main building by a covered way, and the foremen's offices are in the "towers" or projecting structures in the middle of the main buildings. The floors are, I think, eighty feet wide, and are as well lighted as is possible from the sides only. Colt's Armory exerted a great influence on American shop construction; it was undoubtedly the best of its period; it is of such form that only a part needed to be built at first, as more could be added when demanded; in the dimensions adopted it gave more floor-room than a hollow square form on the same ground area, was equally well lighted, had shorter lines of work-travel and official travel, and gave detached work-rooms, which have, until lately, been generally regarded as desirable, or even indispensable, features of industrial architecture. At the present time, however, both the working need for the separate-room feature of the machine shop and its economy are denied. In late light manufacturing examples the separate room has been wholly avoided, except for japanning,—electro-plating, brazing, and polishing and grinding being placed on the same open floor with all the ordinary light machine tools and vise work. Japanning demands an enclosure by itself, because of dust, and because of its ovens, but chiefly because the dust of any workshop would be fatal to the lustre of finished "enamelling," as japanning is now termed by the bicycle makers,—although enamelling on metal is a well-known art wholly distinct from the japanning in which most cycle framework is finished. The foundry should also be kept in a building or enclosure by itself, although it is not separated wholly from machine-tool floors in the Lane & Bodley shops of Cincinnati. A vast majority of machine-shop superintendents would, however, insist that the foundry, and its close adjunct, the castings-cleaning and pickling room, should be in separate enclosures, and the smithy is also thought to be better placed in a separate structure. In many of the cycle factories, which are at present our most advanced light machine shops, brazing is put in a detached building ; in other factories brazing fires appear in close connection with machine tools without the slightest inconvenience. Speaking generally, it is undoubtedly correct to put the foundry, the rattlers and pickle tubs, and the hammers in separate rooms. The drawing room must also be in a separate enclosure, and should never be, though it often is, a part of a thoroughfare from the office to the shops, or from one portion of the works to another. The old machine-shop practice commonly divided the floor space into many apartments, separated by close partitions : now the best shops have but three shop enclosures,—the foundry, the smithy, and the machine shop. The great economy of the full open floor is as well understood now as it was in the busy days of Colt's Armory, when many of the five-hundred-feet floors were open from end to end without obstruction. A very decided converse to the open shop floor practice has existed, and still exists, in the Pratt & Whitney, Brown & Sharpe, General Electric, and many other large shops ; others again, fully as large as, or even larger than, those mentioned, use one vast floor, every foot of which is open to the simultaneous observation of one man.

Unquestionably the open floor is in every way to be preferred to the separate-room plan for operations which do not interfere with each other. Separate rooms entail a vast amount of needless labor and lost time, even when workmen do their best ; where workmen are not more than commonly honest and earnest in their toil, they fall before the temptation of convenient obscurities, and drop into easy habits of chatting and loitering in spots where the eye of the foreman is not likely to reach them. Separate rooms also waste a very large floor space and intercept light, which is always insufficient in side-lighted rooms, and, taken all in all, perhaps no mistake in shop design is productive of more evil results than that of placing each department or subdivision of work in a separate enclosure. Emphatically the separate rooms in any work shop should be as few as possible. The drawing room, pattern shop, and model room or experimental construction room, are all closely allied departments, and should all be above the first floor, because of dust, and should all be of easy access from the offices. The model or experimental room is often made a part of the tool-making department ; it is often locked up away from everything else, as it unquestionably should be. The development of a new idea is best carried out in secret. For many reasons the offices of the machine shop should be on the second floor. The second floor is, in almost all cases, cleaner, better ventilated, and in every way a more desirable location than the first floor. If the ease of the visitor is to be studiously considered, an elevator can be used. One flight of easy stairs is not a serious objection to the second-floor business office, and a second-floor office is above the dust of the street, which by itself is advantage enough to warrant an elevated location.

None of the early shops were supplied with the traveling crane, now regarded as absolutely indispensable. In Colt's Armory the work was so light as to render cranes needless; the heavy New England shops, like the Birmingham Iron Foundry, the Farrel foundries at Waterbury and Ansonia, the Woodruff & Beach works at Hartford, and the Builders' Iron foundry at Providence, were scantily supplied with jib cranes; the South Boston Iron Works had one large lathe built for the United States government for heavy gun construction, served with a small traveling crane; both lathe and crane are now at Watervliet Arsenal, West Troy, N. Y., the lathe being much nearer modern lines than the crane. The use of a jib crane which could place a heavy piece on a trolley, and another jib crane to take the piece off the trolley, was the accepted practice until recently; up to the time of the electric crane there was no perfectly satisfactory traveling crane; Sellers had done possibly the best that ever was done with the shaft-driven traveling crane: the air-driven traveling crane has the dragging air hose, and the rope-driven cranes are comparatively slow in action. The light air-hoist traveling crane, now so common in good foundry equipments, is not many years old in America, and it is safe to say that up to 1890 the advantages of the traveling crane and the air hoist were not generally understood by our machine-shop managers. The advent of the electric-driven traveling crane revolutionized shop construction for heavy work: the use of this admirable application of electric power transmission effected such savings in handling work as to force its installation in every new shop, and a shop floor full of machine tools and covered by a traveling crane overhead demands a building and method of power transmission for tool driving not known in this or any other country until late years. For all shops handling pieces of as little as five hundred pounds' weight even, the traveling crane is needed, and, where the work reaches into ordinary steam-engine proportions, this agent is indispensable.

The Walker Manufacturing Company's shops, Cleveland, Ohio, are said to be among the first, if not the very first, of American machine shops fully equipped with traveling cranes; at the present time no shop intended for heavy work would be built without the installation of traveling cranes wherever they could be made useful, and the type of shop cross section shown in the Walker, Niles, and Laidlaw-Dunn Gordon shops lends itself so readily to traveling-crane requirements that it has come to be regarded as settled practice.

Space does not permit any extended consideration of the important points of machine-shop design affected by power transmission and crane support. Present practice warrants the prediction of electric driving, probably with a continual decrease in the use of leather belting, down to the minimum of a single belt for driving individual tools; possibly the present favorite practice of electric-driven short-line shafts may become the standard; cranes will be altogether electric driven, and the air hoist will be largely used.

This paper is written in the full belief that the form of machine-shop buildings has a very great influence on the labor cost of machine work.

It may seem impossible to the experienced machine constructor that really good and really well-equipped and well-managed shops can be handicapped by the mere shape of buildings to the extent of ten per cent. in the total labor cost of production; yet the writer is convinced, by a very extended observation of the machine shops of the United States, that a difference of labor effect amounting easily to one hour in every ten hours of labor time can be gained by the use of the best form of shop structure.

Endeavoring to support and maintain the proposition that great economic gains may be made by the adoption of the best general conception of machine-shop design, and also to show from American shop construction practice what this best form of machine shop is, nearly thirty pages of illustrations of notable American machine shops, small and large, old and new, accompany this text, with caption lines indicating the essential features of each.

It is believed that machine-shop construction variations tend steadily towards one certain well-defined form of shop plan, and that this ultimate ground plan can be perfectly supplemented by either wood or brick walls roofed in either of two forms; one, the ordinary ventilated gable roof, of which the Sterling Cycle shops and others are examples; the other, the saw-tooth roof, shown in the Straight-Line and De La Val shops. Of these last two shops only one is homogeneous so far as the workshop roof is concerned, while no instance is known in which the entire assemblage of stores, offices, and workshop is either walled or roofed in the same manner. In the new Westinghouse shops at Pittsburg the very large principal structure is homogeneous throughout, a design having been found which housed workshop-offices and shops in structures of the same outward form, by a variation in flooring. Speaking strictly, there is at present no machine shop and offices building in the United States which is homogeneous throughout, and the De La Val is the only one in which the machine shop is in all its parts an assemblage of simi'ar units.

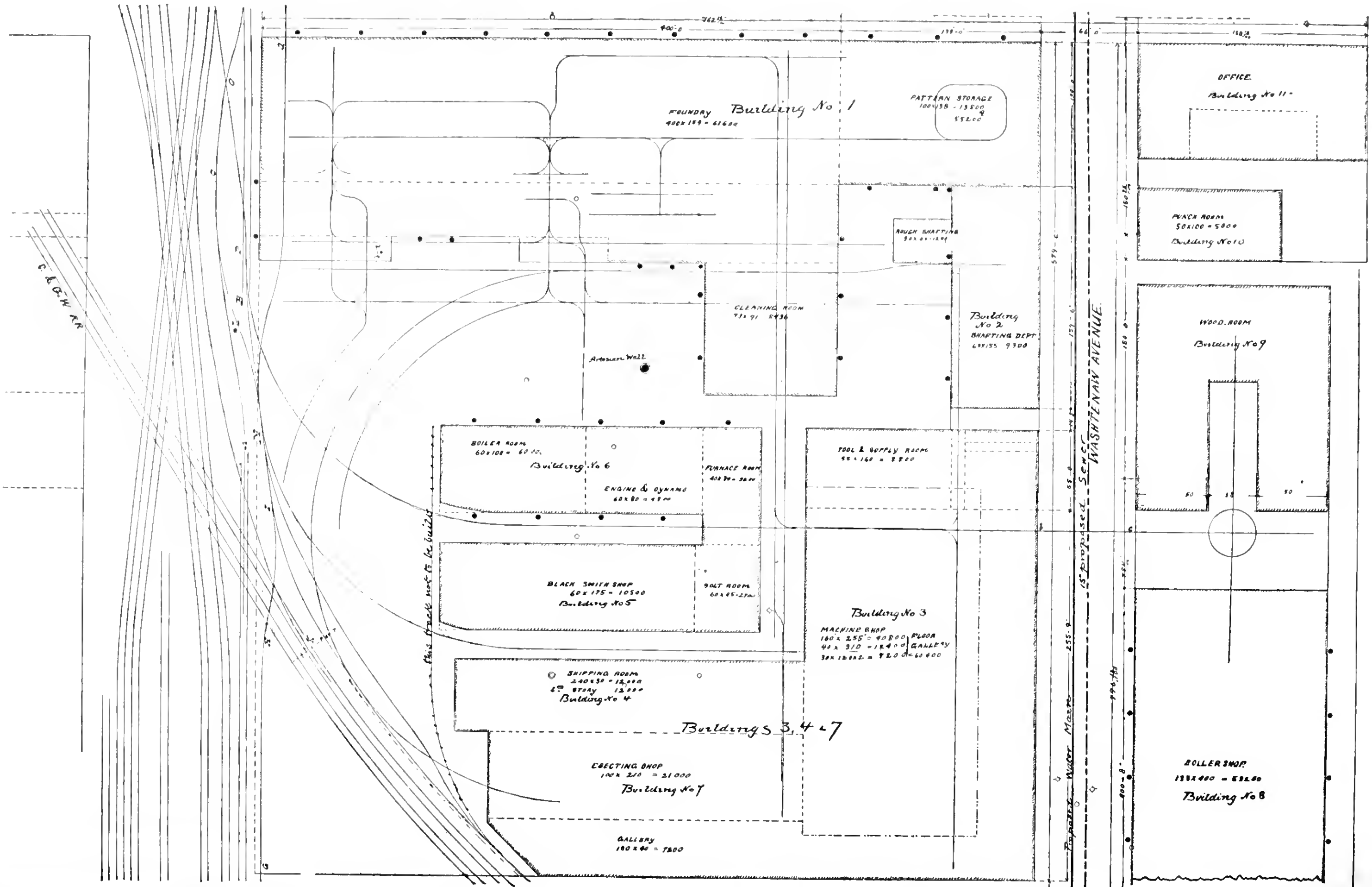
Inspection of the Westinghouse shops was permitted, but illustration was denied, which is to be regretted, as the design is in the line of advance which has been assumed, although not an entire departure from the separate-building practice, and by its magnitude shows—as is shown on a smaller scale by the Sellers, Niles, Tweedvale, Gates Iron Works, De La Val, and Sterling Cycle Factory—that it is not only possible, but in every way convenient and desirable, to put an extremely large machine-shop plant on a single open floor without partitions. The Tweedvale shops have not been personally inspected by the writer, but are believed to be in the line of open main-floor construction. In the Westinghouse, the machine-shop floor is the full size of the main structure ground plan, and unobstructed. This shop does work of all weights from the heaviest to the very lightest, and the transmission from the power house to the shops is wholly electric. The Brown & Sharpe new No. 1 building extension, upon which great thought and expense were bestowed, makes no use of electric driving: the power transmission is with flat leather belting. The Monarch Cycle Shop's new building, Chicago, has a rope drive for its main lines of shafting. The Baldwin shops are using a mixed system of power transmission, tending toward a uniform practice of placing the dynamo between the engine and the shafting. It is probable that the rope drive is more economical than the flat leather belt, and that electric transmission is the best of the three systems. No case is known where the change has been made from electric back to belt transmission. Electric-driving power transmission carries power to any desired point at extremely small cost, and permits the use of small motor units, so that, except for machine-tool cone belts, leather belting need not be a transmission element. There is but one possible rival to electric transmission of power. Gas can be carried in pipes even more cheaply than an electric current can be carried by a conductor, and, if the heat and noise of the gas engine can be eliminated or in any manner made unobjectionable, then the gas engine in small units will perhaps supplant the dynamo and electric motor. Let this be as it may, the machine shop constructor is no longer hampered by the necessity of carefully-considered means for distributing power; he can lead his power wherever he can run a wire, and a motor, at a cost of $50 or $60, will drive any ordinary machine tool.

In view of the examples shown, there would seem to be no question as the best form of the machine-shop floor : it should be a rectangle, the more nearly square the better, all wide open. The floor, in the Gates Iron Works example, is supported by the earth directly ; in the De La Val shops the floor has an open air space under it. The walls, except in shops of very small extent, will not carry the roof, which will be supported by metal columns, like the traveling cranes. The practice of heating by the blower system, may be said to be well established. The foundations for such a structure have very small loads to sustain.

Hence it is clear that, if the single open floor be adopted as the desirable workshop condition, a very cheap construction may be used. The Mackintosh & Seymour shops are said by the owners to cost $0.50 per square foot of floor surface. The De La Val shops, of wood, with elevated floor and air space underneath, cost about $0.75 per square foot. Brown & Sharpe write that the foundations of their buildings are unusually substantial and expensive, and that the buildings are fire-proof, and were built partly by contract and partly by day work, and that, with cheaper foundations, they might have been erected for $2.50 per square foot of floor surface. The De La Val concern believes it could not suffer much loss by fire (although the shop is a wooden structure), because there is so very little of the walls, and that little is so widely distributed. The Gates Iron Works could suffer the loss of its offices, and so could the Mackintosh & Seymour shops, the Sellers, the Walker Manufacturing Company, Laidlaw-Dunn-Gordon, the Straight Line Engine shops, and any of the single-floor single-room structures ; none of these places could have their machine tools much hurt by fire, and such a building as the Mackintosh & Seymour Shops stands in very small danger of burning. Generally speaking, the danger of fire increases rapidly with increase of superimposed floors, and the multi-floored shop structure is a constant menace through fire liability, unless built fire-proof at great expense.

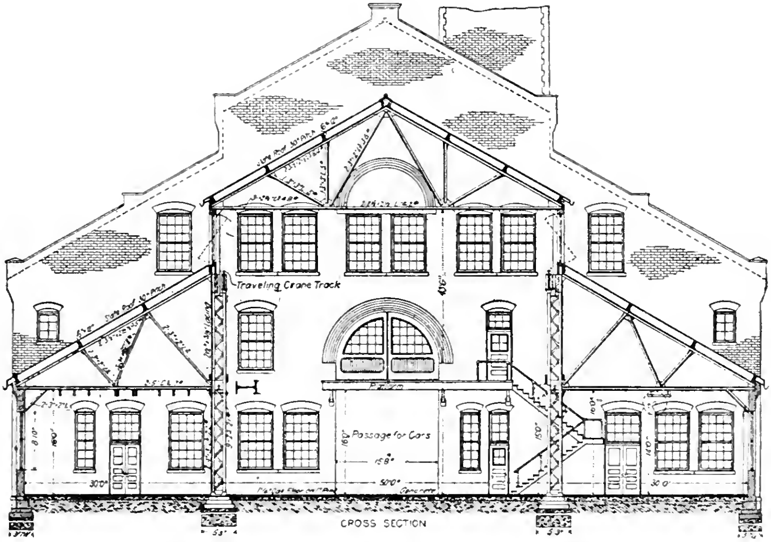
It is very important that a machine shop should be capable of extension as business increases, that the workshops and offices should have the best relative arrangement, and that both shops and offices should be lighted in the best possible manner. In a succeeding article I shall show a composite machine-shop design, embodying only features selected from examples of actual construction here illustrated. A shop built after such a design would be capable of extensions as business increased, would be always perfectly lighted in any environment, and would embody the best known offices and shop arrangement.

(To be continued.)



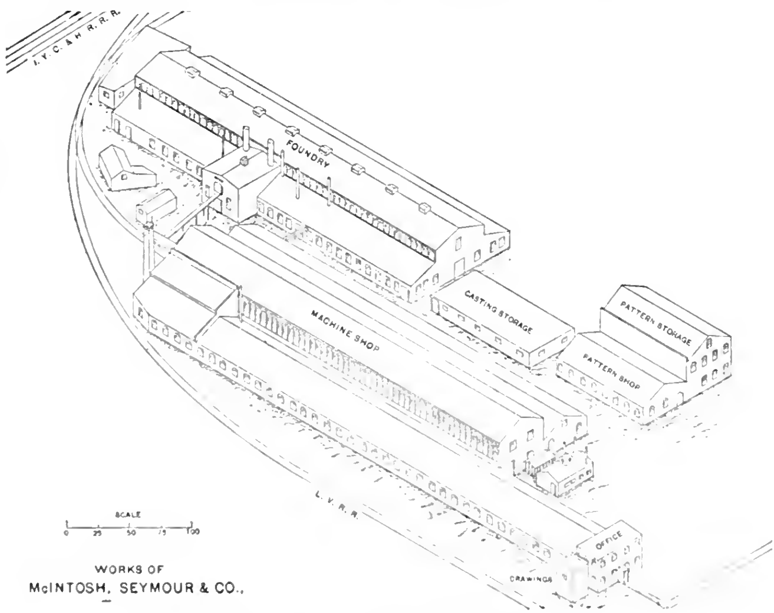
FRASER & CHALMERS NEW SHOPS, CHICAGO.

Foundry built, other works in progress; separate buildings of superior design and great magnitude; multi-floored where work permits; design influenced by considerations which govern the general electric plants, Brown & Sharpe, Baldwin & Lozier Cycle Co.



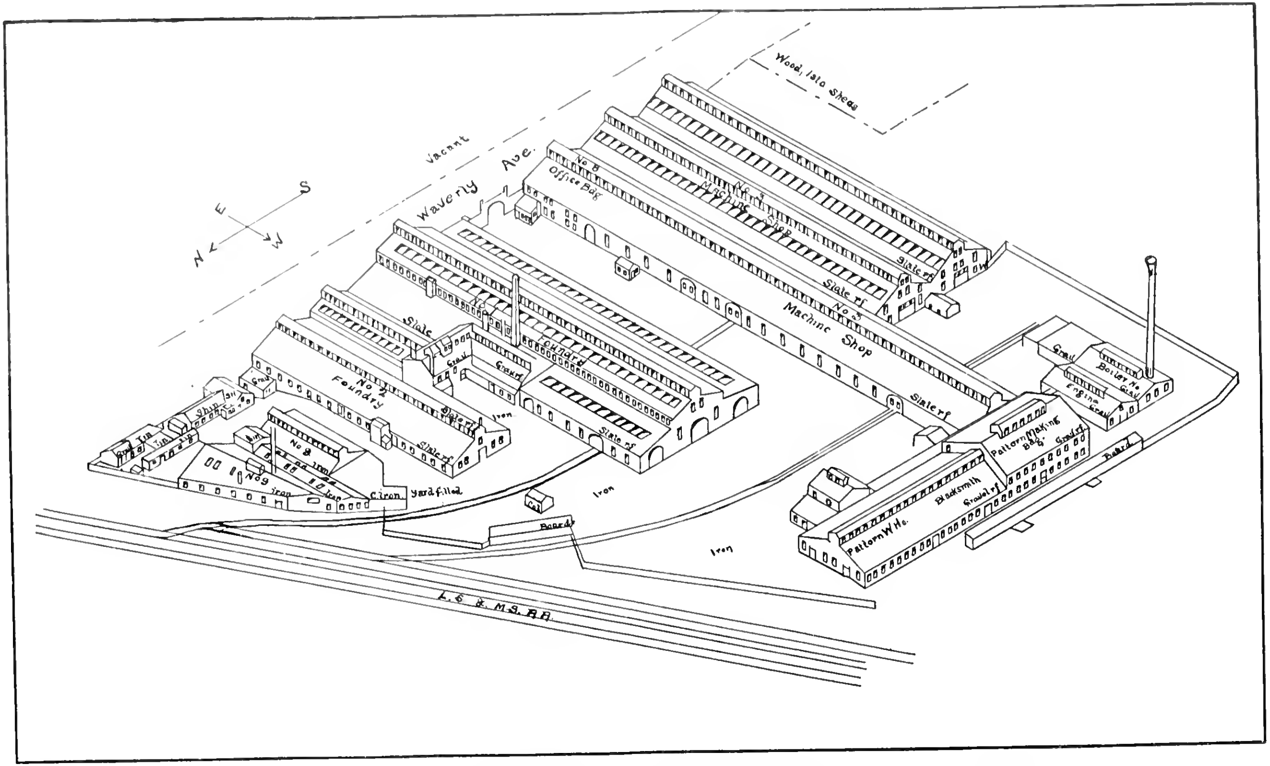
LAIDLAW-DUNN-GORDON TWEEDVALE SHOPS, NEAR CINCINNATI, OHIO.

Single floor, open structure. For plan see page 276.



THE MCINTOSH & SEYMOUR ENGINE SHOPS, AUBURN, N. Y.

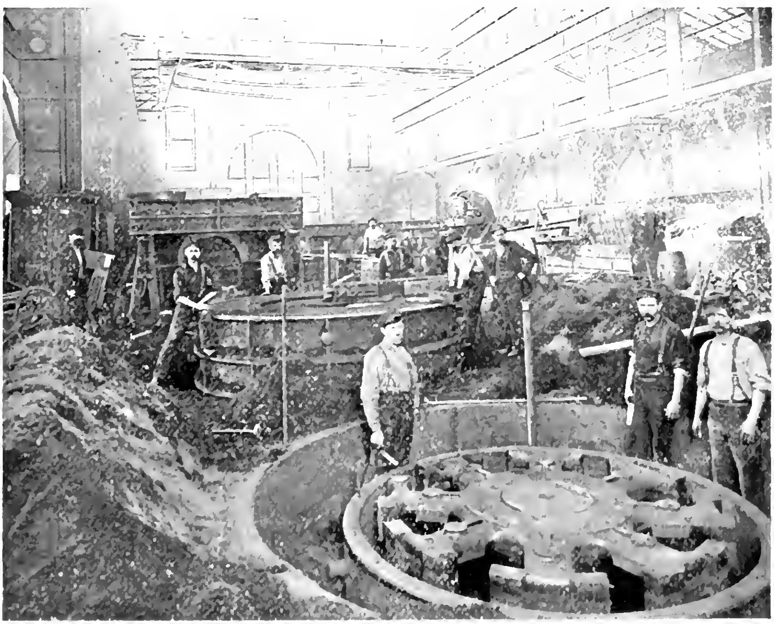
These are small single-floored open shops, extremely well lighted, and very favorable examples of a good low-cost construction of side-lighted shops.



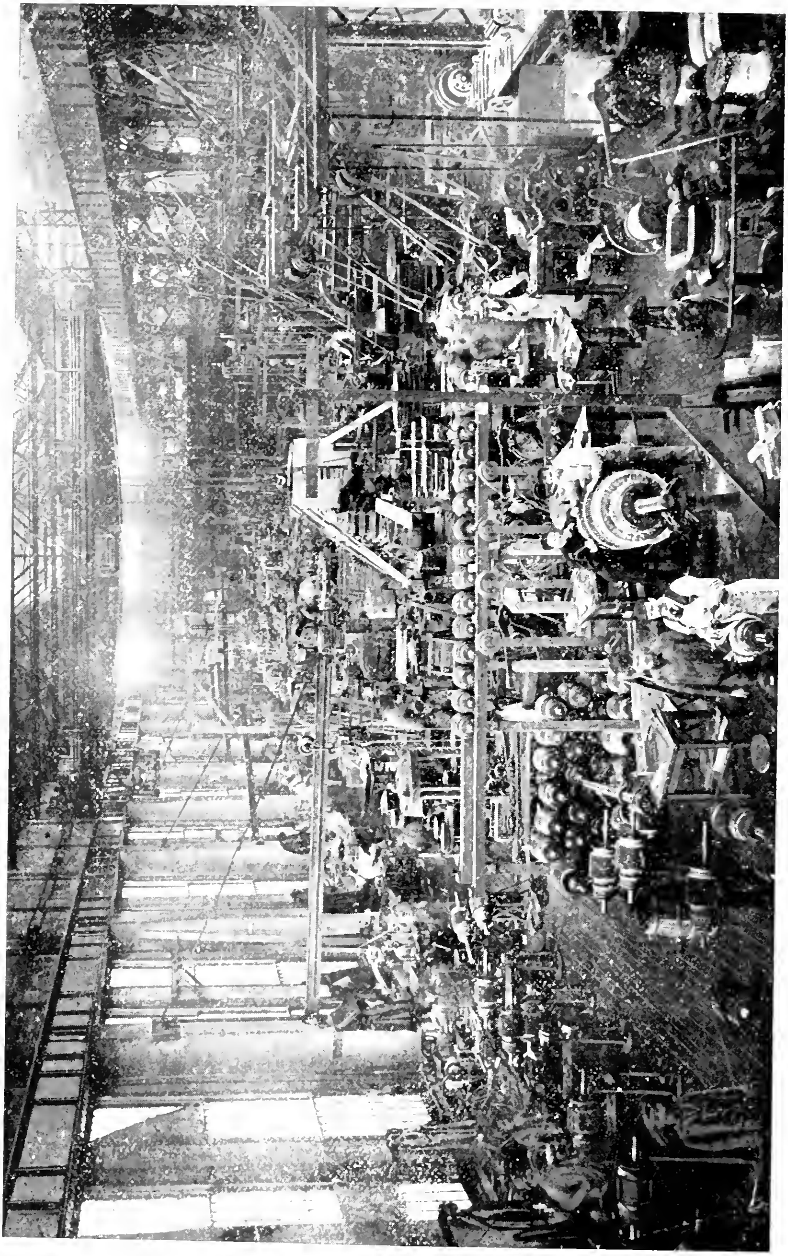
WALKER MFG. CO , CLEVELAND, OHIO.

Generally rectangular form with close grouping of similar structures, single floors, traveling cranes, and unobstructed areas of observation.

WALKER MFG. CO., CLEVELAND, OHIO.

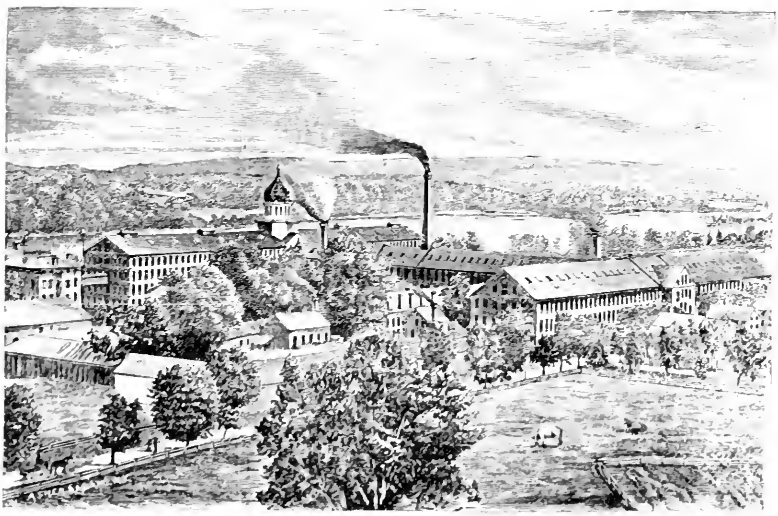


FOUNDRY INTERIOR, WALKER MFG. CO.



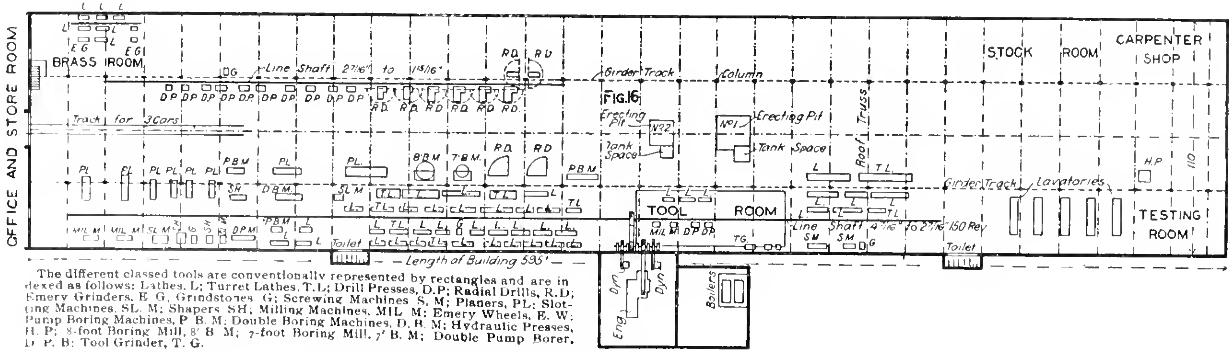
DYNAMO FLOOR, WALKER MFG. CO.

COLT'S ARMORY, HARTFORD, CONN., VIEW FROM N. E.



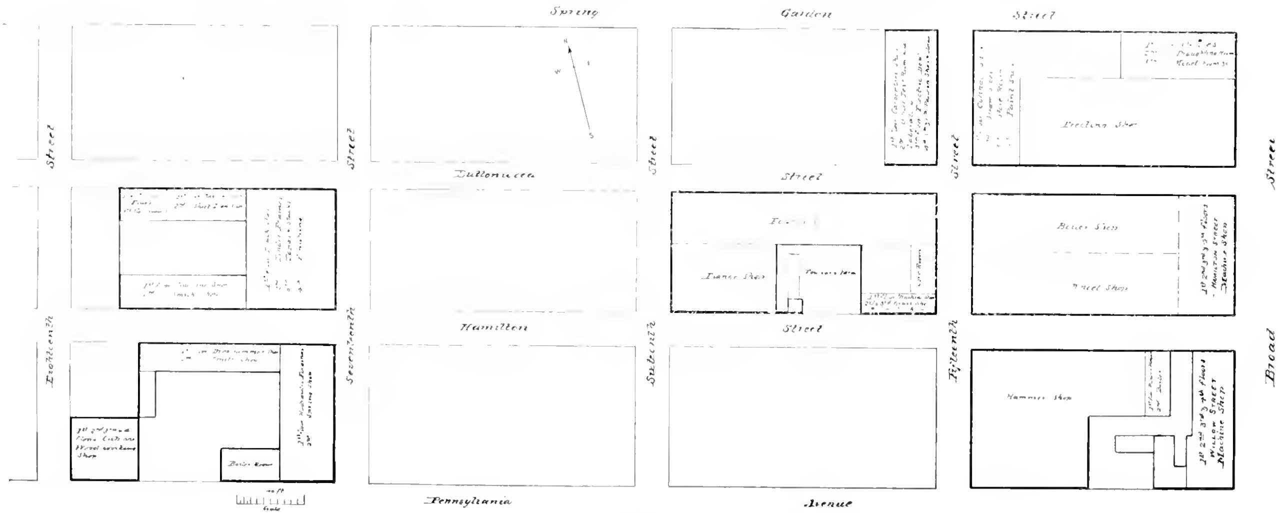
VIEW OF [illegible] ARMORY.

At the time of its completion, 1855, this was among the best manufacturing machine shop buildings in existence, and was long regarded as a model establishment. Its marked features were: H ground plan, each member 500 feet long, multi-floored, brick; subsequently increased by wings extended from the H cross bar. View from N. W.



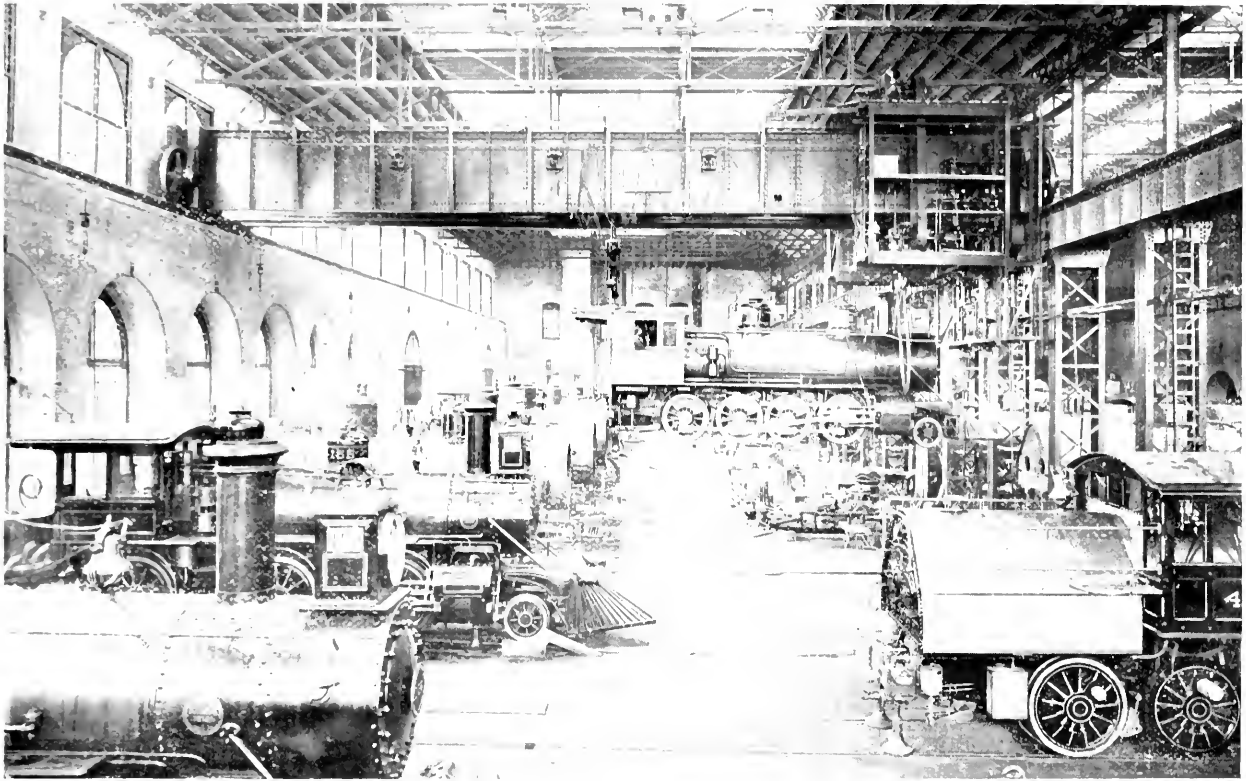
The different classed tools are conventionally represented by rectangles and are indexed as follows: Lathes, L; Turret Lathes, T. L; Drill Presses, D.P; Radial Drills, R.D; Emery Grinders, E. G, Grindstones G; Screwing Machines S. M; Planers, PL; Slotting Machines, SL. M; Shapers SH; Milling Machines, MIL M; Emery Wheels, E. W; Pump Boring Machines, P. B. M; Double Boring Machines, D. B. M; Hydraulic Presses, H. P; 8-foot Boring Mill, 8' B. M; 7-foot Boring Mill, 7' B. M; Double Pump Borer, D. P. B; Tool Grinder, T. G.

PLAN OF LAIDLAW-DUNN-GORDON SHOPS, TWEEDVALE, OHIO. FOR ELEVATION SEE PAGE 271.



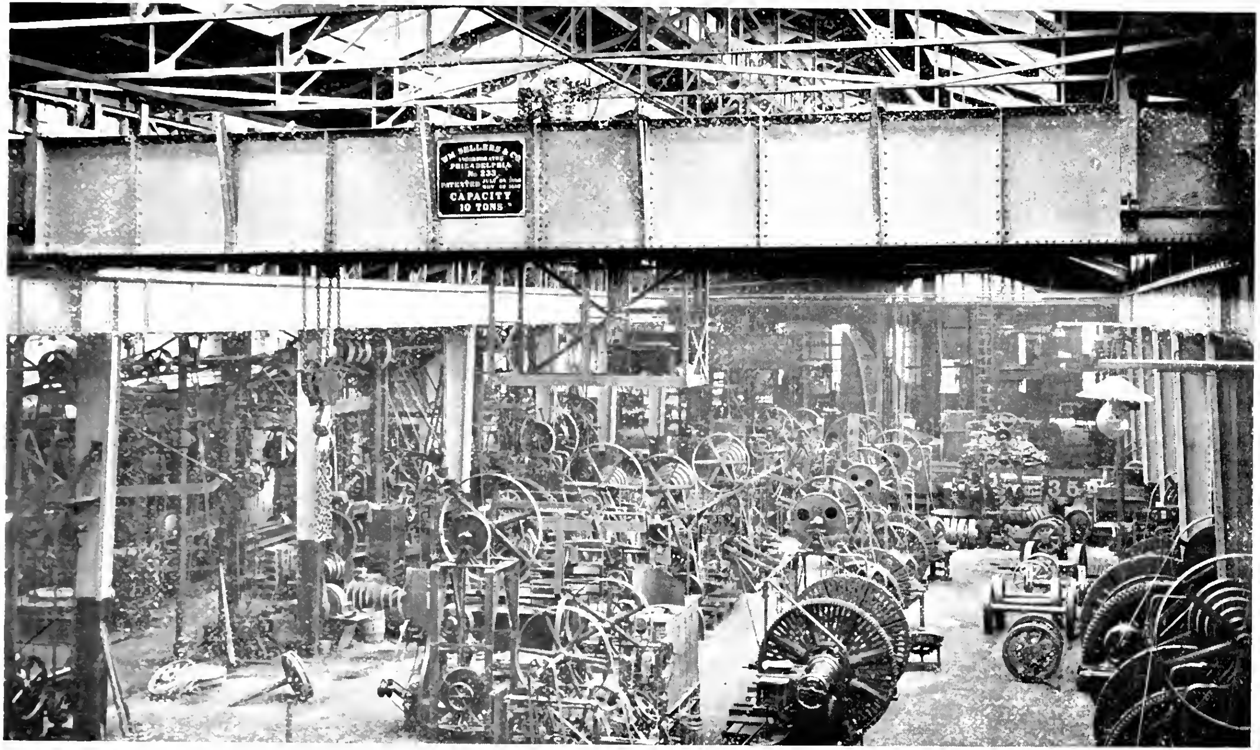
PLAN OF BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA, PA.

Separate buildings, multifloored where more than one floor is possible, within the past few years supplied with traveling cranes and electric driving extensively introduced.

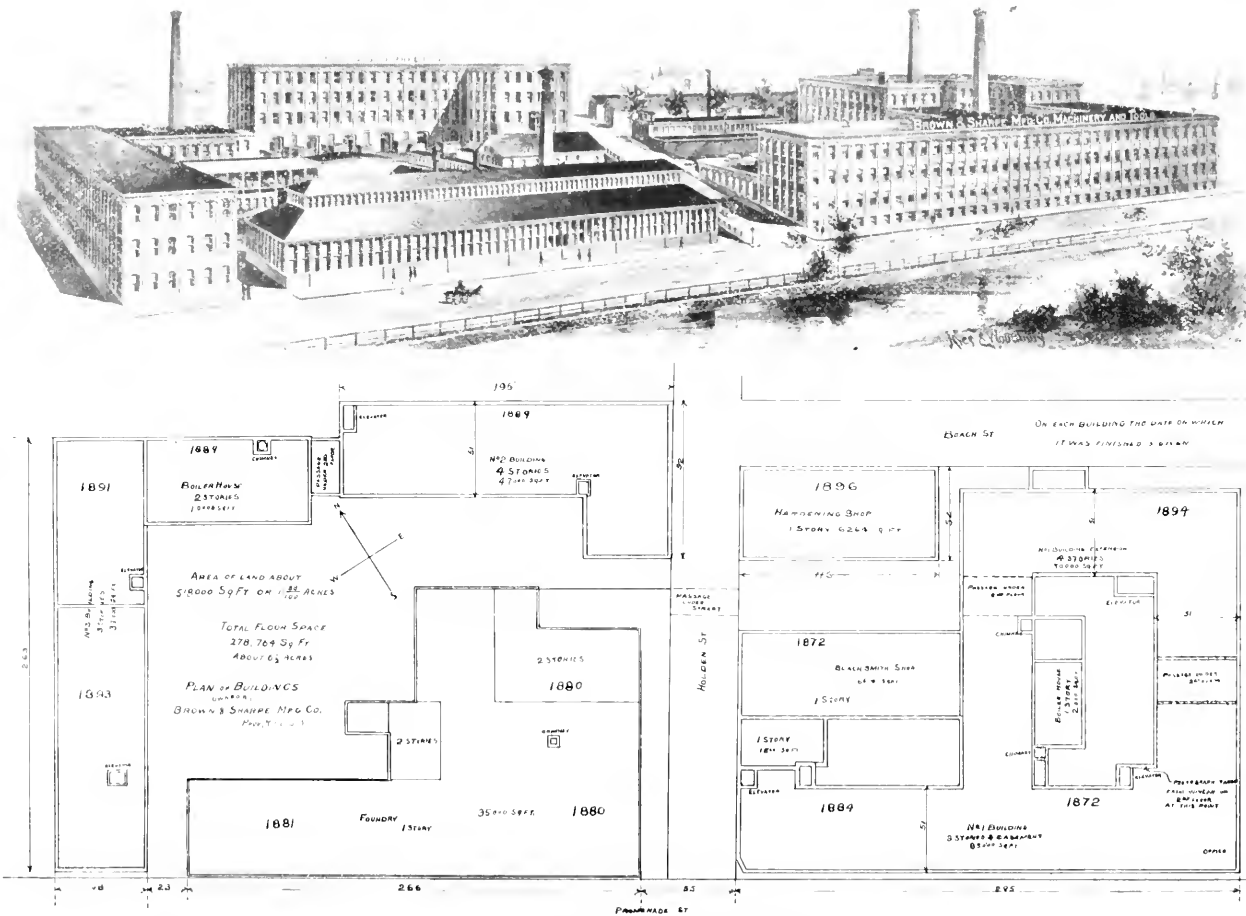


ERECTING FLOOR. BALDWIN LOCOMOTIVE WORKS.

FOUNDRY, BALDWIN LOCOMOTIVE WORKS ; JIB CRANES TO SERVE THE FLOOR AND SMALL ELECTRIC CRANES ON EACH SIDE OF JIB CRANES TO CLEAR THE FLOOR.

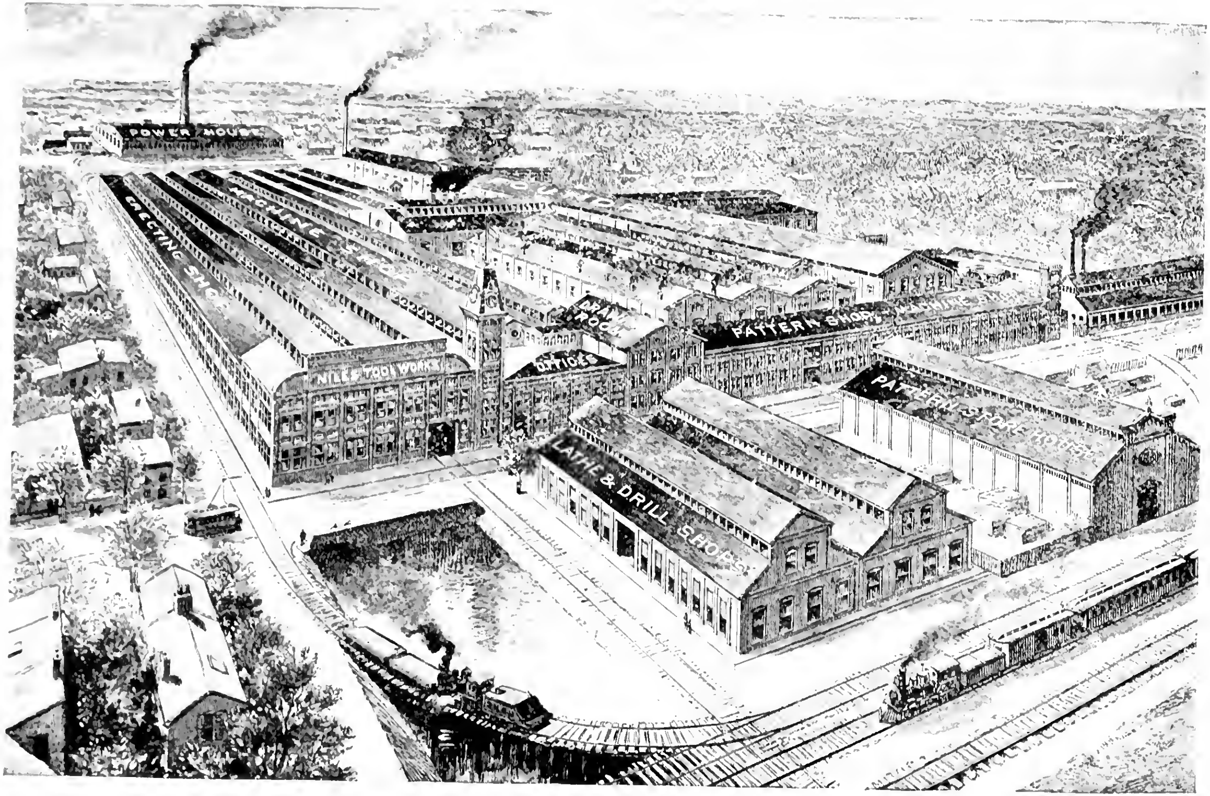


ELECTRICALLY DRIVEN WHEEL LATHES, BALDWIN LOCOMOTIVE WORKS.



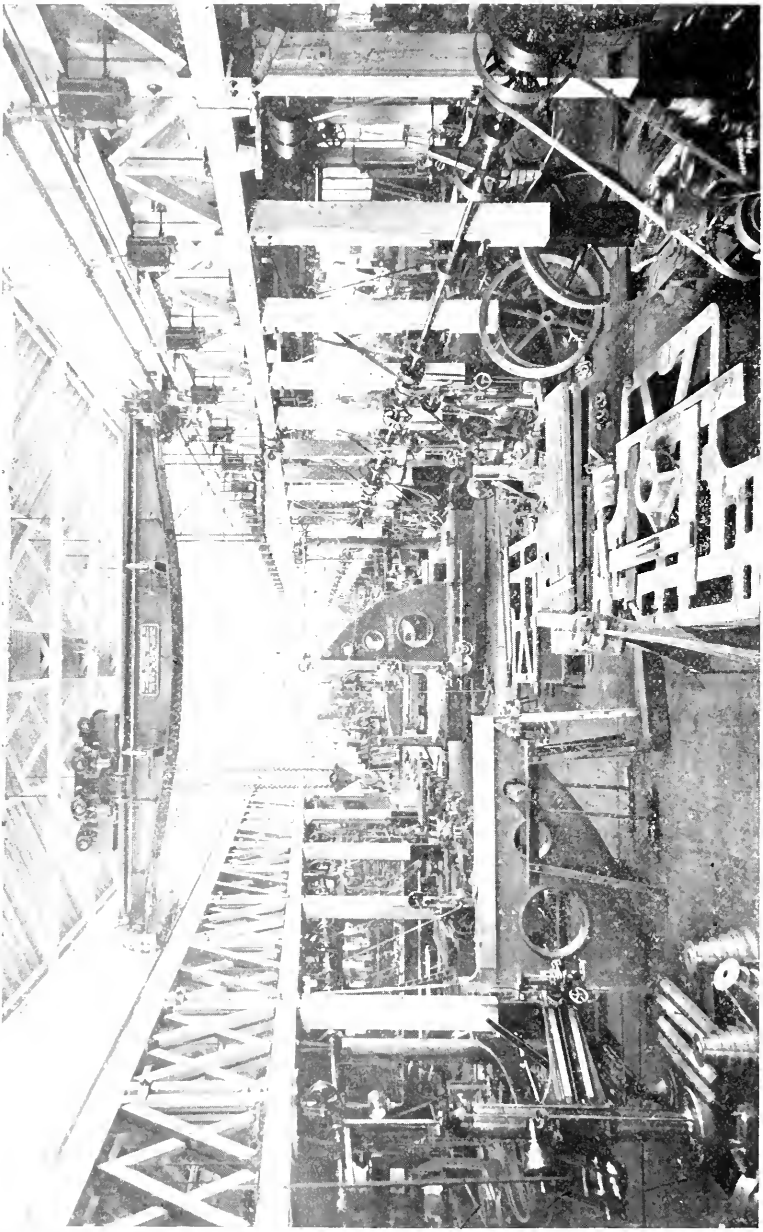
BROWN & SHARPE SHOPS, PROVIDENCE, R. I.

Separate buildings, multi-floored, perhaps the very best that can be done with this type of shop structure; advanced in detail.

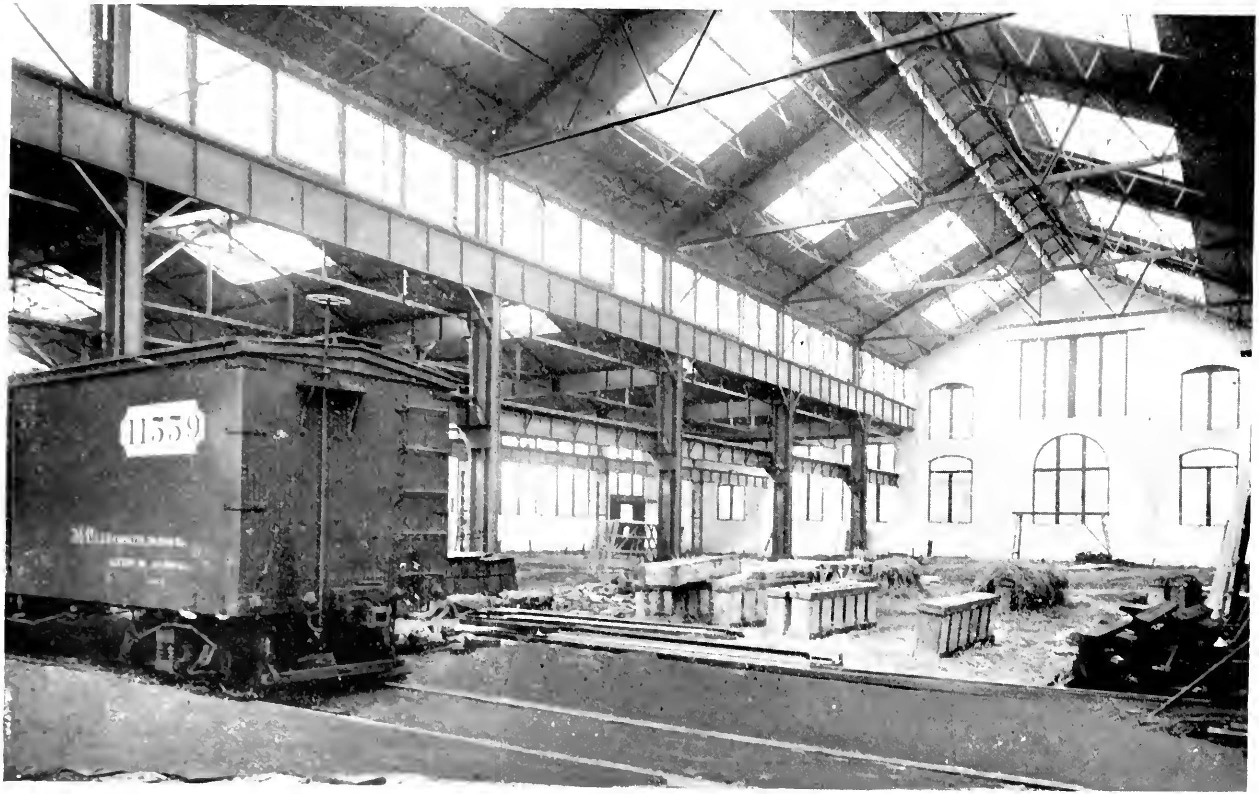


NILES TOOL WORKS, HAMILTON, OHIO.

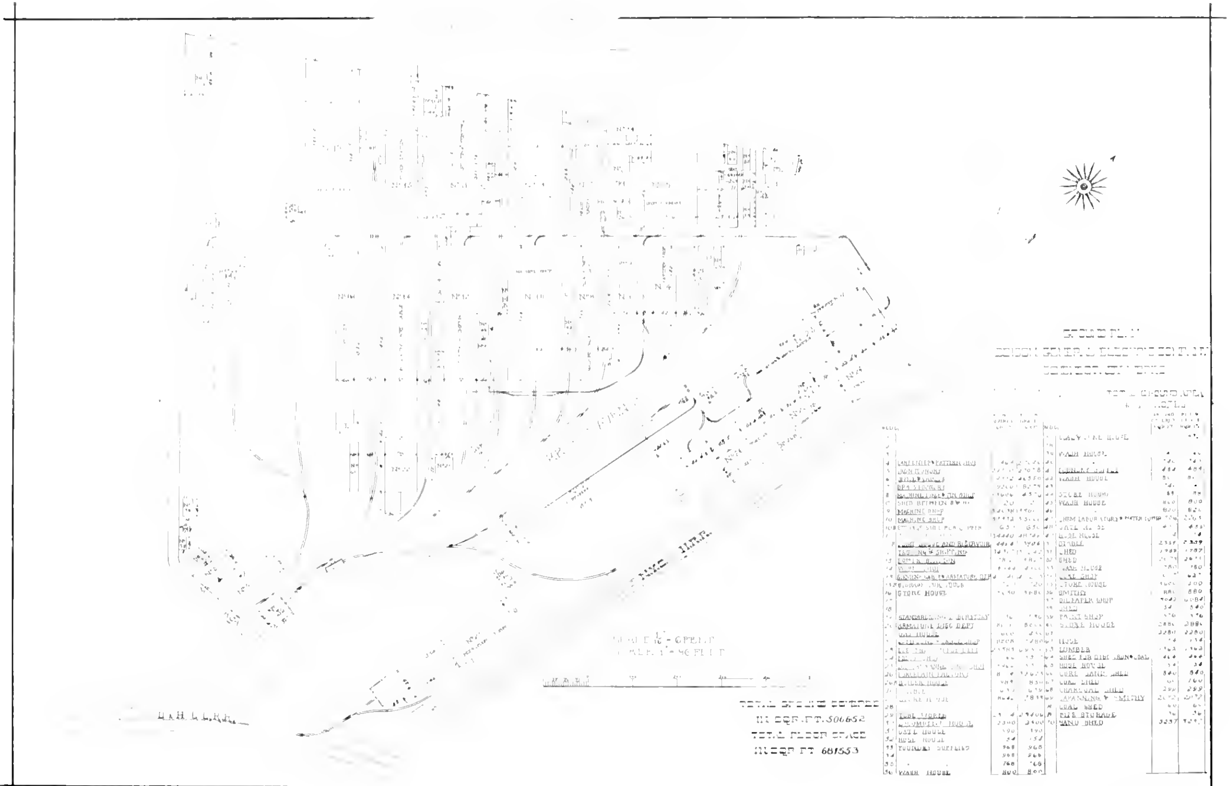
Single floor, rectangular plan, close grouping, unobstructed view, traveling cranes; design dominated by the same general motives as the Sellers, Walker, Straight Line Engine, De La Val, Sterling Cycle, Gates Iron Works, and Tweedvale shops of Laidlaw Dunn-Gordon Company.



ERECTING FLOOR, NILES TOOL WORKS, HAMILTON, OHIO.



NEW FOUNDRY INTERIOR, NILES TOOL WORKS.

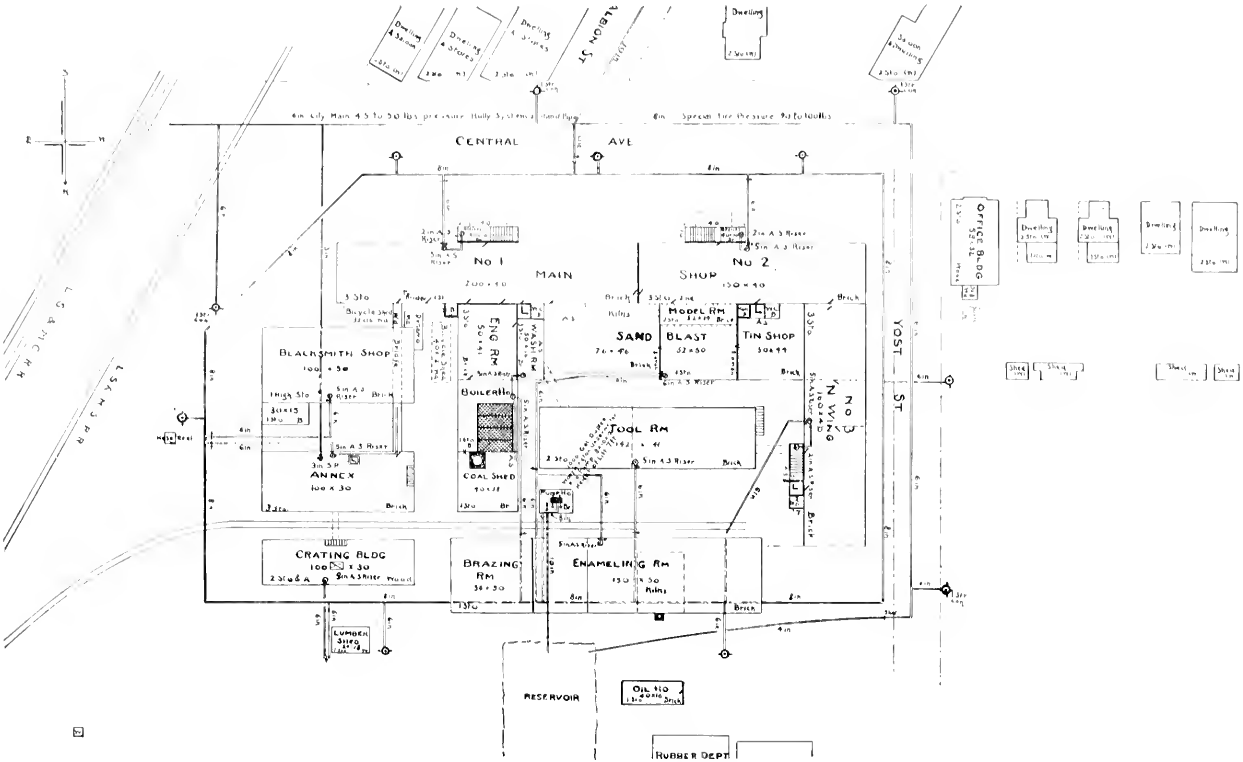


0-401

GENERAL ELECTRIC SHOPS, SCHENECTADY, N. Y.

Separate buildings, multi-floored where the weight of work permits; largely electrically driven.

GENERAL ELECTRIC SHOPS, SCHENECTADY, N. Y.



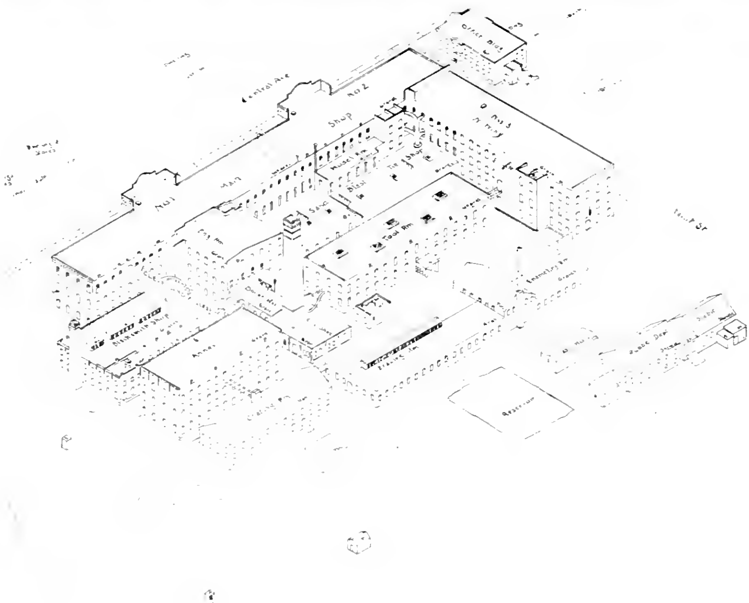
LOZIER CYCLE SHOPS, TOLEDO, O.

Separate buildings, multi-floored where work permits, 1894-5.

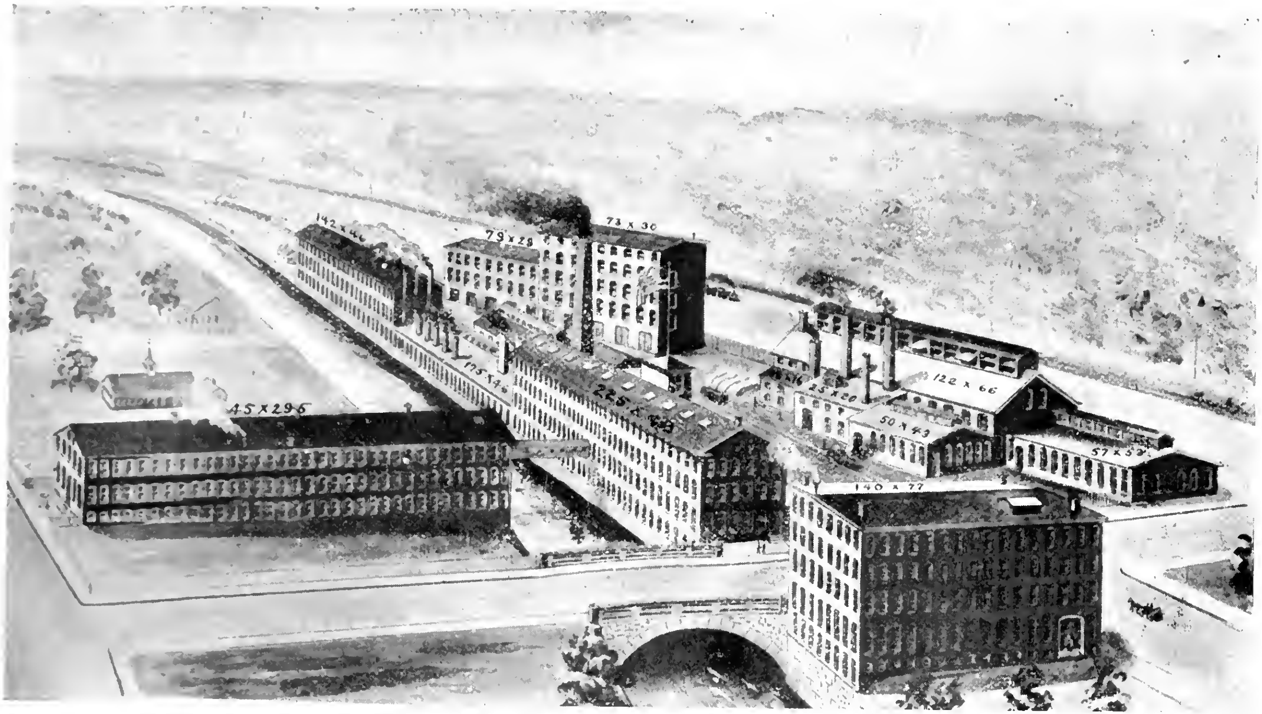
LOZIER CYCLE SHOPS, TOLEDO, OHIO.

INTERIOR, LOZIER CYCLE SHOPS.

STERLING CYCLE SHOPS, KENOSHA, WISCONSIN. FOR PLAN, SEE PAGE 298.

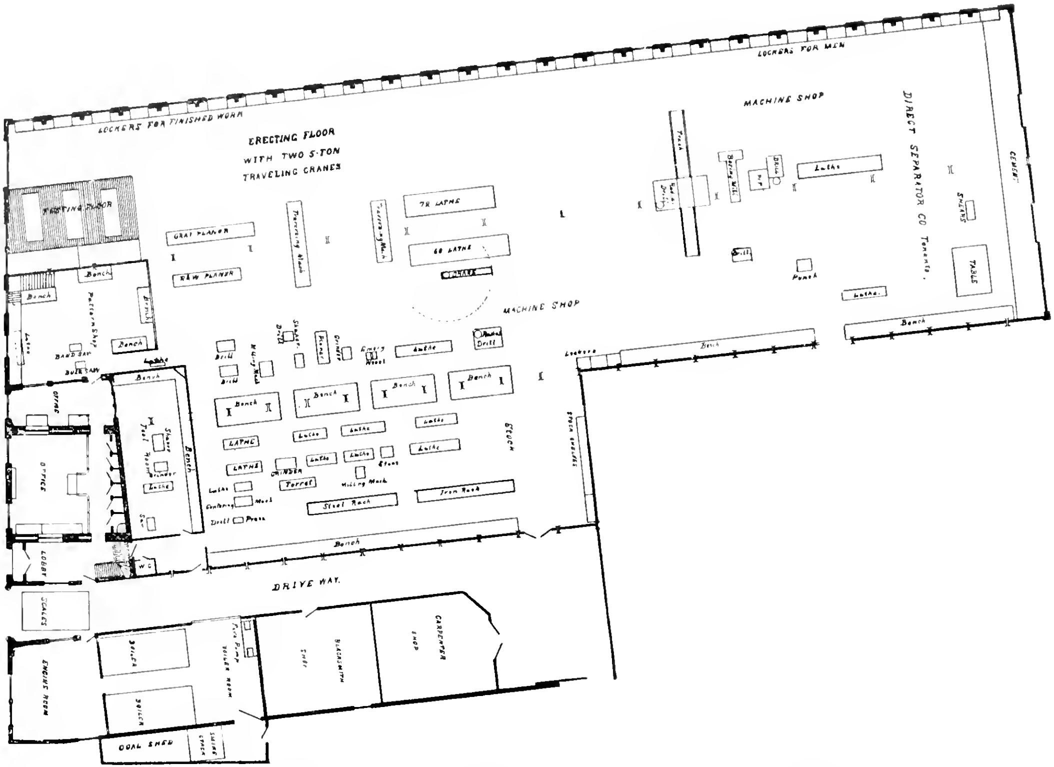


LOZIER CYCLE SHOPS, TOLEDO, OHIO.

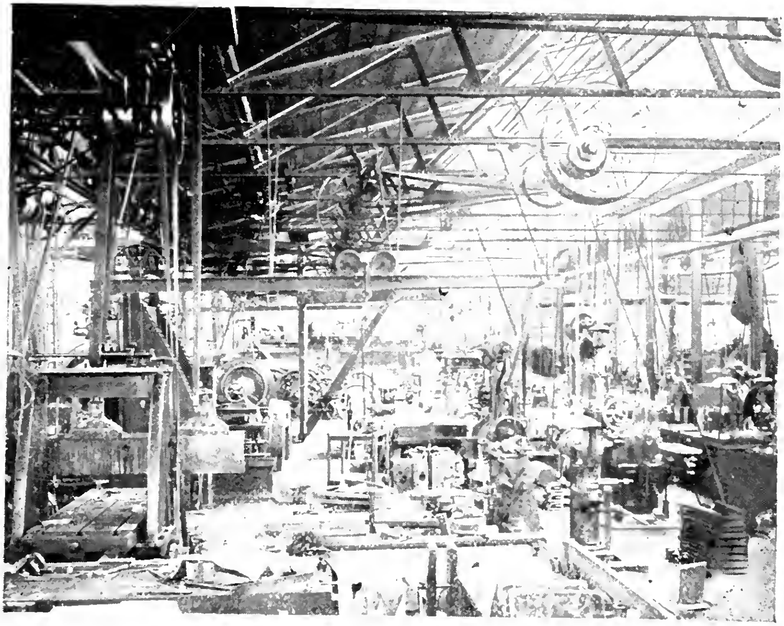


THE PRATT & WHITNEY SHOPS, HARTFORD, CONN.

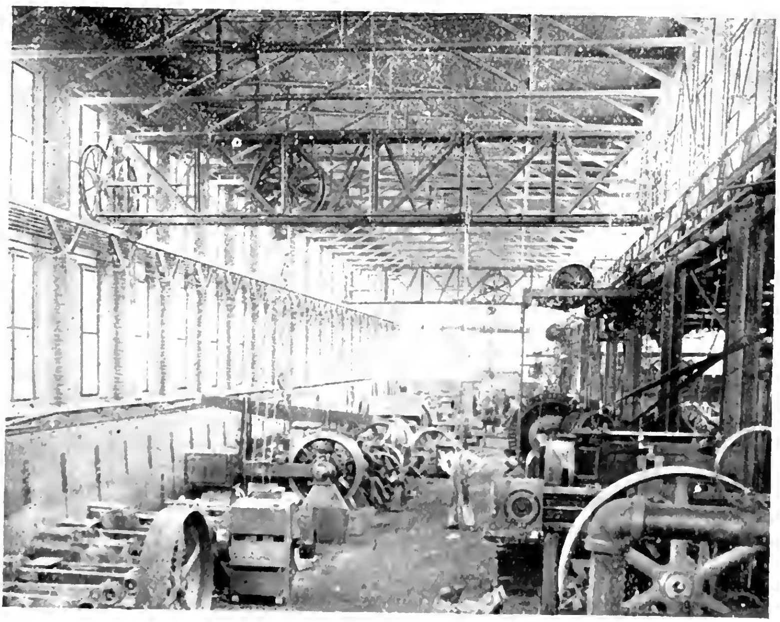
Separate buildings, increased from time to time from small beginnings.



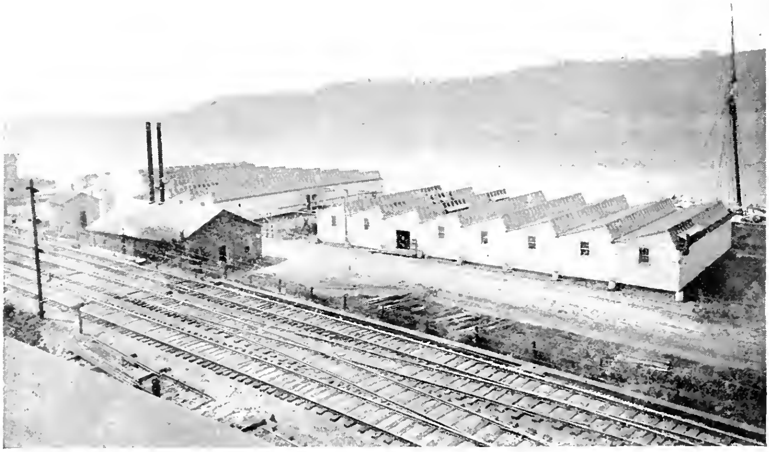
SWEET'S STRAIGHT LINE ENGINE SHOPS, SYRACUSE, N. Y. SINGLE FLOOR, SAW-TOOTH ROOF.



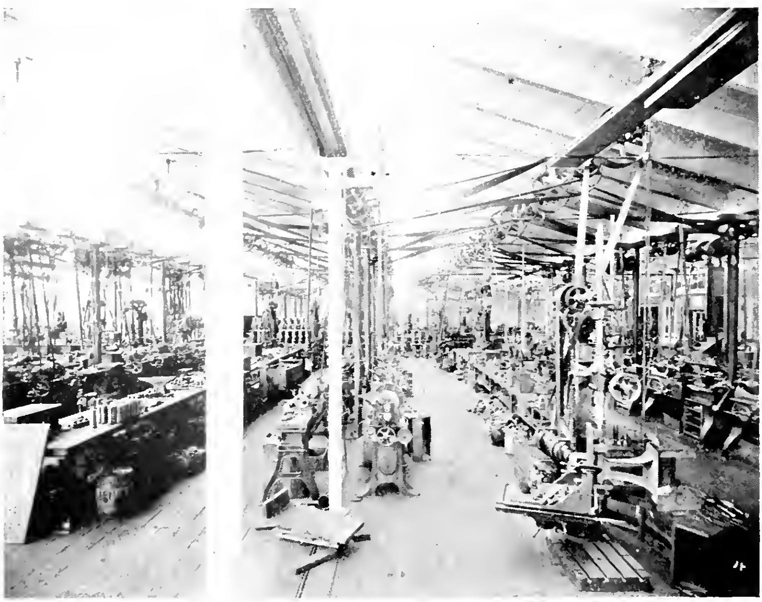
INTERIOR, STRAIGHT LINE ENGINE SHOPS. LIGHT FROM SAW-TOOTH ROOF.



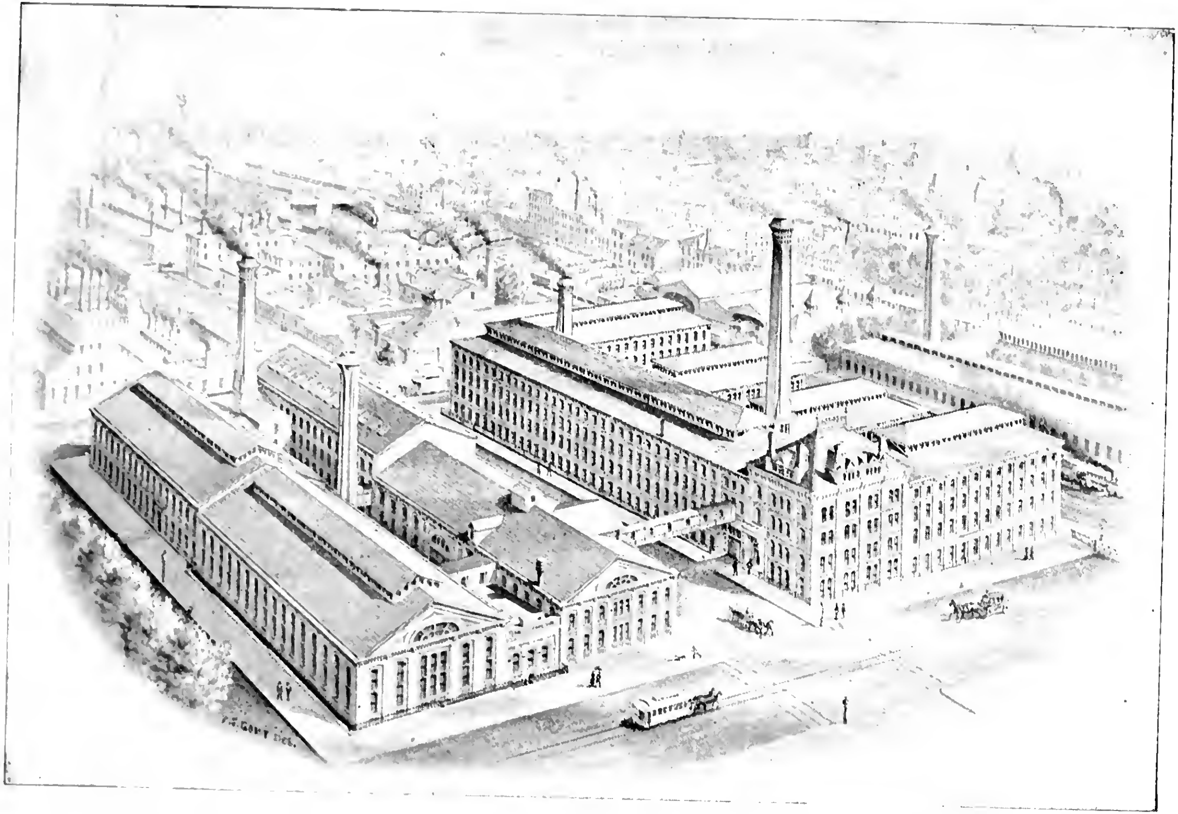
ERECTING FLOOR, STRAIGHT LINE ENGINE SHOPS.



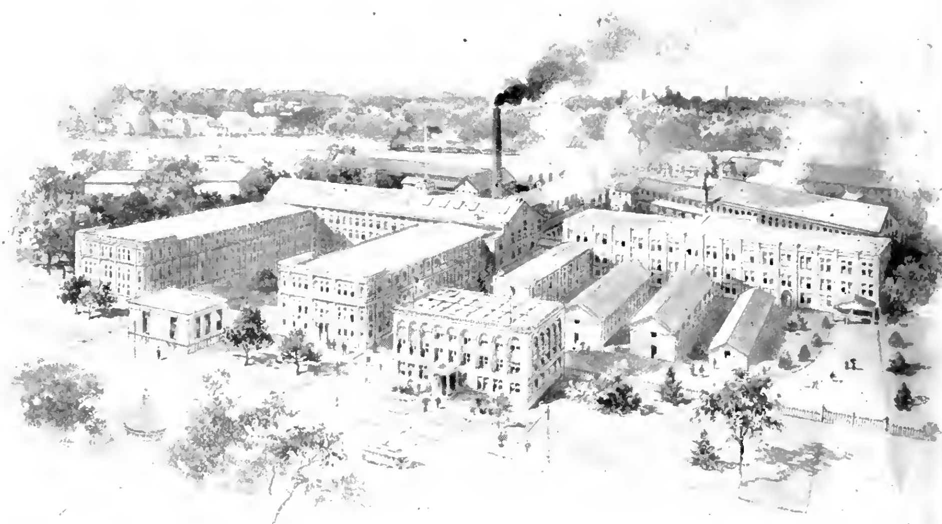
DE LA VAL SHOPS, POUGHKEEPSIE, N. Y. SINGLE, OPEN FLOOR, SAW-TOOTH ROOF.



INTERIOR, DE LA VAL SHOPS.

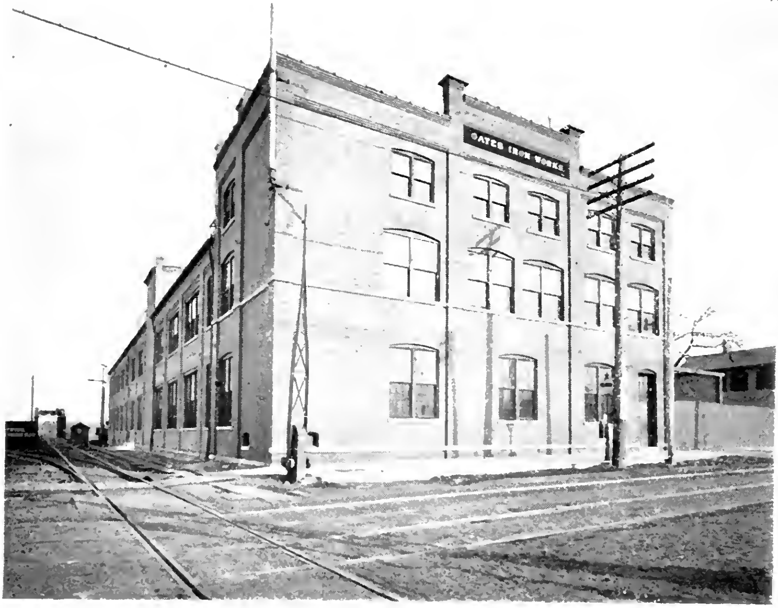


WM. SELLERS & CO., PHILADELPHIA, PA. RECTANGULAR GROUND PLAN, SEPARATE BUILDINGS, BRICK, 1853.



COLUMBIA CYCLE FACTORY—HARTFORD, CONN.

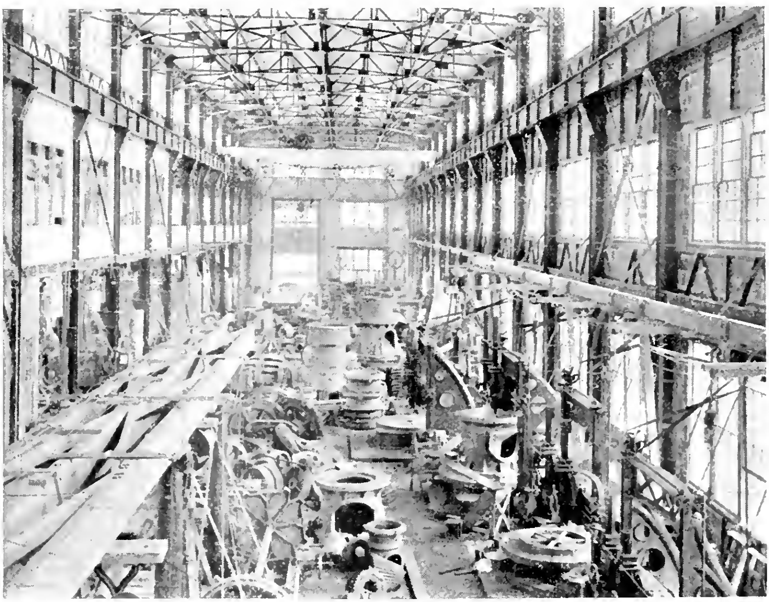
Separate multi-floored brick buildings, built at different times. Multi-floored office building in front.



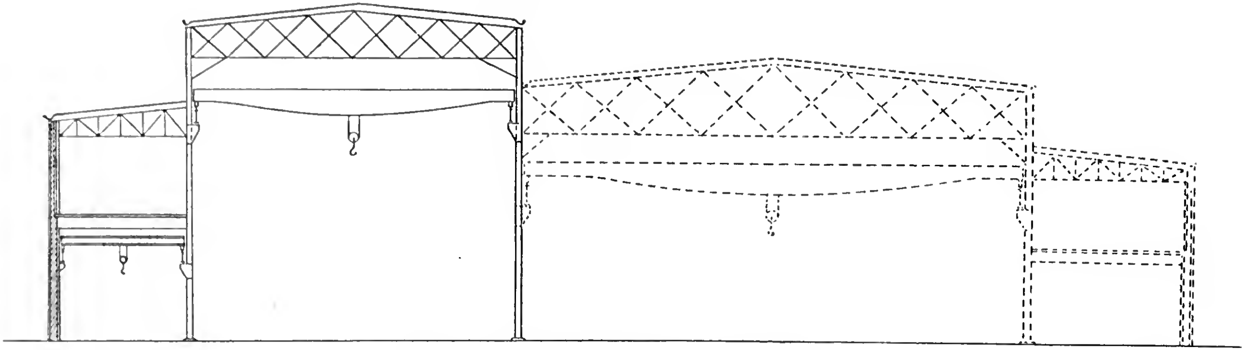
GATES IRON WORKS, CHICAGO, ILL.

GATES IRON WORKS.

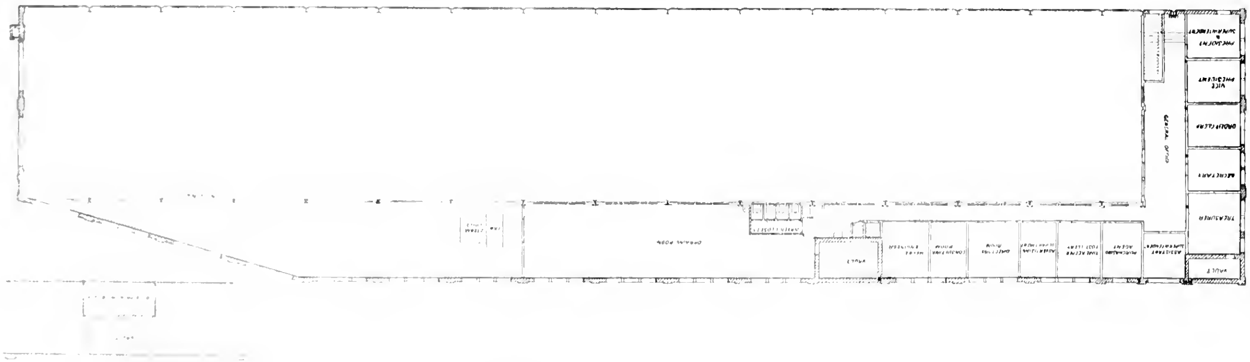
DRAFTING ROOM, GATES IRON WORKS



INTERIOR, GATES IRON WORKS.

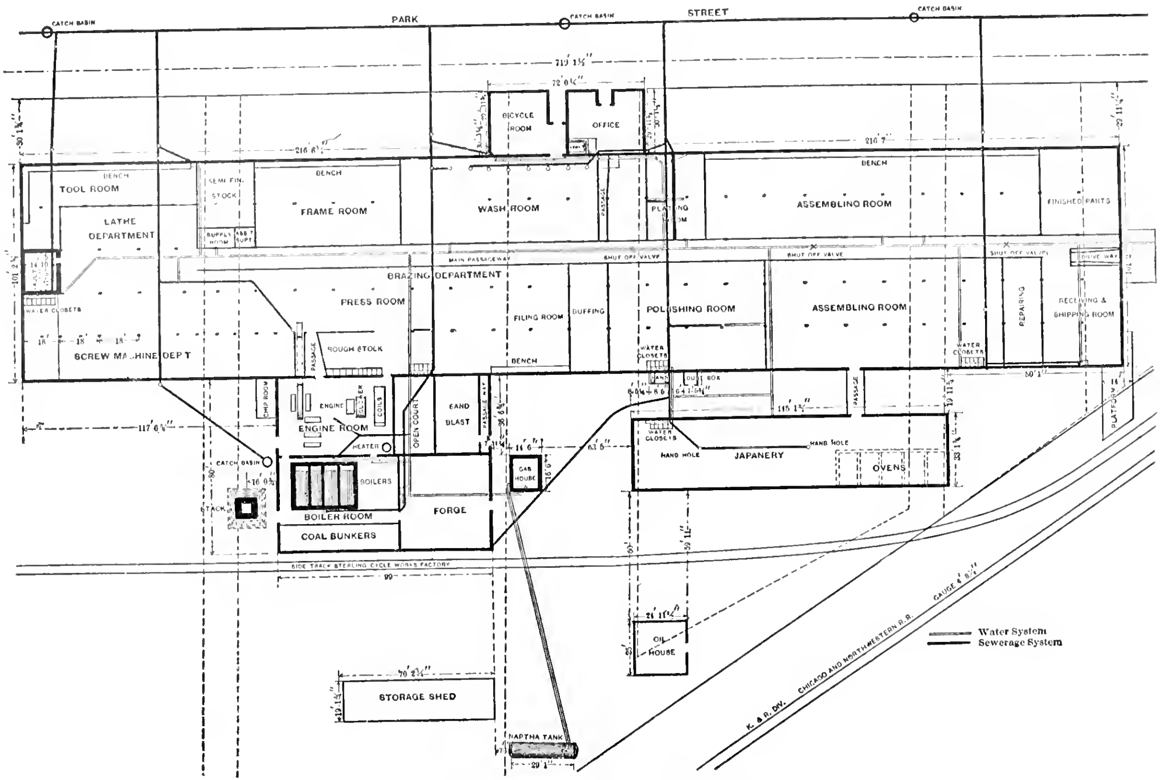


ELEVATION, GATES IRON WORKS, CHICAGO, ILL.



GROUND PLAN, GATES IRON WORKS.

Showing individual-room offices on second floor overlooking shop floor and facilitating inspection; single floor, open structure.



STERLING CYCLE SHOPS, KENOSHA, WISCONSIN.

Main building 500×100 ft. with single floor and open structure, separate japannery, 1895. For exterior view see page 288.

MINOR MINERALS OF THE UNITED STATES.

By David T. Day.

THE mines of the United States yield an average annual product worth \$600,000,000. While this product fluctuates greatly according to industrial prosperity, it increases with the growth of population. Indeed, while our population increased only twenty-five per cent. from 1880 to 1890, the mineral product increased just three times as rapidly, or from \$350,000,000 to \$619,000,000. We should, therefore, in 1900 normally produce about an even billion dollars in minerals.

We record about fifty mineral industries, each contributing a distinct product. Nevertheless, nine-tenths of the total is furnished by a dozen minerals, and more than a third by two,—coal and iron. The rest are the minor minerals.

AVERAGE VALUE OF MINERAL PRODUCTS OF THE UNITED STATES.

	Millions of Dollars.		Millions of Dollars.
Bituminous coal	120	Aluminum	$\frac{1}{2}$
Pig iron	100	Whetstones	$\frac{1}{8}$
Anthracite coal	85	Corundum	$\frac{1}{8}$
Silver	75	Feldspar	$\frac{1}{10}$
Building stone	45	Bromine	$\frac{1}{10}$
Gold	40	Barite	$\frac{1}{10}$
Copper	35	Grindstones	$\frac{1}{10}$
Petroleum	30	Mica	$\frac{1}{10}$
Natural gas	14	Manganese	$\frac{1}{12}$
Lead	12	Graphite	$\frac{1}{12}$
Clay	10	Antimony	$\frac{1}{20}$
Zinc	7	Sulphur	$\frac{1}{20}$
Cement	6	Fluorspar	$\frac{1}{20}$
Salt	5	Marl	$\frac{1}{20}$
Mineral water	4	Chrome iron ore	$\frac{1}{30}$
Phosphate rock	4	Infusorial earth	$\frac{1}{40}$
Limestone for iron flux	3	Millstones	$\frac{1}{50}$
Mineral paints	2	Nickel	$\frac{1}{100}$
Quicksilver	1	Cobalt	$\frac{1}{100}$
Borax	1	Tin	$\frac{1}{100}$
Soapstone	1	Magnesite	$\frac{1}{100}$
Gypsum	$\frac{2}{3}$	Asbestos	$\frac{1}{200}$
Pyrite	$\frac{1}{2}$	Platinum	$\frac{1}{2000}$
Asphaltum	$\frac{1}{2}$	Rutile	$\frac{1}{3000}$
Precious stones	$\frac{1}{4}$		

This classification, however, is not the popular one. Popularly speaking, any mineral is minor which is not frequently mentioned in the technical press; but with such a classification every chance discovery which should give a mineral sudden and temporary notoriety would take it out of the list of minor minerals. Thus, one of our most popular mineral products is aluminum; yet it is a very minor mineral product, not worth a tenth of our salt. Tin is even a less considerable product in this country. Indeed, the total tin product of the world is not worth half as much as our common clay products, which make an aggregate value greater than either silver or gold.

Cement, salt, mineral water, phosphate rock, paints, borax, soapstone, asbestos, aluminum, nickel, cobalt, tin, platinum, quicksilver, antimony, gypsum, pyrite, precious stones, asphaltum, whetstones, bromine, bauxite, corundum, barite, manganese, graphite, sulphur, marl, chrome iron ore, infusorial earth, millstones, magnesite, and rutile are the products which we find in the minor mineral column of our mineral wealth. Of them the first six are always millionaires. Some of the others go beyond that limit, but fluctuate widely. The limiting reasons which keep these substances in the minor list are the most really interesting features of them. This limitation is usually due to one of three things,—to a limited market, principally, but in other cases to the difficulty of finding a supply, and, again, to the fluctuations of other industries to which these mineral products are minor tributaries.

Where lack of supply is the trouble, the mineral has obtained a sudden popularity, to which there has not yet been time to adjust the producing conditions. This usually changes in a few years to a surfeited market, and a loss of interest in the mineral because of abundance. But, where the mineral is a very secondary consideration in some other industry, like sheet mica in stove-making or quicksilver in gold amalgamation, its fluctuations are especially uncertain.

Aluminum.—Considering the minerals under the three heads mentioned, we find that aluminum is typical of the substances of which we cannot get enough. Its product has jumped from 283 pounds in 1885 to 950,000 pounds in 1895, while its price has dropped from $8 per pound in 1885 to a minimum of 35 cents in 1895. This total product is not great, comparatively. Still, if the rapid increase continues, we should produce at least 3,000,000 pounds in 1900.

Aluminum's popularity is due to its lightness, whiteness, and freedom from any considerable tendency to rust. It has certain disadvantages, but these are not so notable as is the lightness of the metal. Its production in this country is limited to one firm, in spite of hundreds of patents and applications for patents for methods of making it. The producers have the best process known, and the patent has been shown to be good. It has not been the policy of the controlling company to offer royalty privileges in so favorable a way as to induce others to go into the manufacture. The nature of this simple process (Hall's) is too well known to need mention, but in its development, and in other investigations in search of new methods, much has been learned of metallurgy, and two valuable substances—carborundum and calcium carbid or acetylid—have been discovered.

Aluminum is an attractive substance for experiment. It is one of the best conductors of heat; it has a very high specific heat; it tarnishes, but does not rust readily. It is easily rolled or drawn into wire; it can be beaten into an extremely thin leaf. It is an ideal casting metal, and the possibilities of hardening it by alloys offer an extremely valuable and even fascinating field for investigation. It is over-used in many directions, but still the demand is beyond the supply. Singularly, most of it has been used in alloy with iron to improve iron and steel castings, but in the future, with decreasing prices, most must go to making kitchen utensils, till it shall drive first copper, and then tin plate, from the field. If the price goes much lower, copper will be menaced in various fields,—such as electric connections. It would then displace also roofing tin and terne plate. Unfortunately for this prospect, there seems comparatively little chance for reducing its cost much below the present rate of 35 to 50 cents.

Sources of Aluminum.—It is a somewhat curious fact that, in spite of the inability of the manufacturers of aluminum to supply the present demand, there is no scarcity of available ores. It is the common impression that clay is the main source of supply. As a matter of fact, aluminum made from clay is an experimental curiosity, and probably will remain so for many years, because there are richer sources which furnish an abundant supply. The supplies which have been drawn upon have varied curiously. The first aluminum made in the United States in any considerable quantity was from Irish and French bauxite, but later bauxite, fairly free from silica, which was discovered in Alabama and Georgia, was used to a considerable extent, the members of the Pittsburg Reduction Company going so far as to acquire large deposits of it. Next, the far more abundant supplies of bauxite in Arkansas were experimented with, but proved too siliceous, a small amount of silica being as great a detriment in making aluminum by the Hall process as is the iron which is found as the considerable impurity in the bauxites of Alabama and Georgia. But, while the southern bauxite was being used in the manufacture of aluminum, being first sent to Syracuse, New York, where it was refined, and then shipped to Pittsburg for conversion into aluminum, the alumina from Greenland cryolite entered as a competing factor. Inasmuch as the alum into which this alumina normally goes has become a drug on the market at present, this source of supply controls the trade, and is likely to so long as the quantity of aluminum is sufficient, which can be only for a short time. It will then remain an open question which of the various sources will be further drawn upon, with a possibility of using alumina obtained by a double decomposition of the phosphate of alumina which makes up the raw phosphates from Orchilla and other islands. It is possible to obtain phosphate of alumina in comparatively pure condition, not only from these islands, but from several points in Florida. It seems practicable to produce alumina in perfectly pure condition from this source, and to leave calcium phosphate in a condition suitable for the assimilation of plants without further treatment by acid, and to do this as cheaply as crude bauxite can be refined to the necessary extent for making aluminum. Evidently, therefore, there is a supply of aluminum ores sufficient to yield great quantities of the metal without the use of clay. And, before these supplies are exhausted, will come the question as to whether further supplies of bauxite are not liable to be found under the conditions present in the Coosa valley. They will be sought farther to the northeast in the Appalachian system, wherever the geological conditions are similar. These conditions seem to be a very complicated system of faulting extending through the Knox dolomite and into the underlying shales. Hayes has shown that, where this faulting has taken place, it has admitted the downward percolation of water carrying atmospheric oxygen, which has oxidized the iron pyrite contained in these shales. The free sulphuric acid which, in addition to ferrous sulphate, has resulted from this oxidation has dissolved out the alumina, and thus nature has performed one stage of the conversion of clay into aluminum. First it made aluminum sulphate, and alum where the clay also contained potassium, and then this solution, passing upward, was acted upon by the Knox dolomite, forming gypsum and alumina, carbonic acid probably passing off into the air.

Magnesite.—Another mineral belonging in the group in which the supply is by no means equal to the demand is magnesium carbonate, which is in more or less demand according to the extent to which it has been concentrated as pure magnesite or, on the other hand, left with a large proportion of calcium carbonate, as dolomite. A map of the occurrence of magnesium minerals over the United States would show concentrations of this material wherever there is serpentine. We should think particularly of a more or less persistent system of such serpentine rocks in the Appalachian series most noticeable in Maryland and eastern Pennsylvania, and again in western North Carolina—a series which will be referred to as the source of our deposits of chrome iron ore, nickel, and corundum. Here pure magnesite has been repeatedly noticed, but not in commercial quantities. Again, on the Pacific coast the occurrence of chrome iron ore in belts of serpentine has also been coincident with deposits of magnesite, and in this State there are beds, reported as from five to six feet thick in several cases, and in one case from five to twenty feet, which would be of considerable commercial importance if located near the points of consumption. But the total supply of magnesite so far found in the United States is entirely insignificant compared with the need of this material as a lining for basic open-hearth steel plants, and recourse has had to be made to dolomite as rich as possible in magnesia. The dolomites preferred for this purpose have been obtained, so far, principally in the neighborhood of Bowling Green, Ohio, and other points where the dolomitic portions of the Trenton limestone are easily available; but in the future the Knox dolomite of Alabama and Georgia will become available, as in the course of time the accumulation of scrap iron in these southern States will admit of open-hearth steel works there. But the supply of this material must be in the neighborhood of the points of consumption; hence dolomite containing anywhere from twenty per cent. to the theoretical forty-five per cent. of magnesium carbonate and less than one per cent. of silica will be greatly sought in western Pennsylvania, in Indiana, Ohio, and Illinois, and just at present in northern New York.

The particular reason why magnesium carbonate is better than calcium carbonate for basic linings is that, the greater the proportion of magnesia, the more infusible is the resulting basic open hearth, and the less liable are the bricks to disintegration by slacking.

The sulphite fiber industry also would be greatly benefited by the discovery of cheap magnesite, because magnesium sulphite is more soluble than calcium sulphite,—which takes the gum from the wood, leaving it in the fibrous condition of wood pulp for paper-making.

Mica.—This is another mineral product which certainly belongs to this group—from the economic point of view. It was a very important feature in stove-manufacture for years. Western North Carolina and New Hampshire were the most convenient sources of supply, and these, together with Pennsylvania, New Mexico, and the Black Hills of South Dakota, controlled the market. The demand was so good that prices were high,—$2 to $10 per pound. With so profitable an industry crude mining methods sufficed. Consequently the inevitable reduction in price, due to the substitution of cheaper grades,—*i. e.*, sheets of smaller sizes,—came as a severe blow to the heedless miners in the North Carolina mountains. They had not learned enough about mining economy to be able to improve their methods, and, where mining was not discontinued, it degenerated into burrowing after such pockets as proved of unusual richness. These occur very irregularly. Mica in small flakes is common enough as a granite constituent, but it is valuable only where the crystals have abnormally developed to huge size. This is the case here and there in a series of three to seven large dikes of granite cropping out along the top of the Blue Ridge in western North Carolina and southward in Georgia. Especially in Mitchell and Yancey counties the mica is found crystallized in large bunches along the walls of these granite masses, where they swell in width. Guided by these indications and largely by accidental discoveries, thousands of pockets have been opened, and hundreds still remain in a condition to partly justify the name of mine. Small pockets worked by ignorant mountaineers furnish most of the present product, thanks to the conservative habits of the men rather than to the profit they make. They carry their product many miles to the country store, and exchange it for supplies. There is little which can stop this irregular supply, so long as any price for the product remains. Where the mines are large enough to justify account-keeping, they have closed down to avoid actual loss. Not long after the decrease in demand due to smaller sizes of mica in stoves, it rose again higher than ever by demand from the electrical industry for building up armatures. Unfortunately for the miner, India came in in 1884 with a new source of supply, which the McKinley tariff of 35 per cent. could not stop. So that to-day, while the consumption is far greater than the amount we supply, the prices are low, and, were it not for the conservatism of the mountain men, the supply would stop altogether. Grinding the waste has helped the industry, but it cannot reopen mines because of the accumulated waste-heaps. Another innovation is the manufacture of opaque sheets of mica, to order, by building them up with shellac from the larger flakes in the waste heap. The result is good enough for all but the best insulation work.

Platinum.—A much-sought metal is platinum, and fully as useful in the arts as gold. Every one is familiar with the vain search which a popular inventor made for this metal in the southern States, basing his search merely on the fact of the common association of platinum and gold ; experience elsewhere should have directed him to the placer gold regions of California and Oregon, where the conditions are somewhat more allied to those in the gold and platinum placers of the Ural mountains. At least the association of platinum with placer deposits from chrome iron-bearing serpentine rocks seems just as important as its association with gold. Platinum mining, as such, does not exist in the United States. A few hundred ounces of crude platinum grains, together with iridosmine and platin-iridium, are saved from the heavy black sands left behind after removal of gold by amalgamation. So far, the independent search for platinum has not been greatly encouraged by men of large means, although there seems to be fair prospect of good results for such an enterprise, particularly in going north along the Pacific coast. The writer hopes to investigate a considerable number of samples from Alaska as the result of the coming summer's campaign on the Yukon river. The American supply comes almost wholly from Russia by way of the English refineries of Johnson, Mathey & Co., and it is the convenience of this source of supply which discourages any great interest in what we might produce. Still, it would be comforting if we knew just where to turn for a sufficient domestic supply, in case, by any accident, the foreign supply were to be cut off. As to its uses, platinum has become a great convenience in chemical laboratories, both in analytical work and in large industrial operations, such as the concentration of sulphuric acid. In these cases it is simply an equation of first cost of a platinum outfit compared with the cost of repairs when using glass which controls this consumption. There are other industries in which the use of platinum is imperative. No substitute has yet been adopted for the short pieces of wire which pass through the glass of an incandescent bulb, and it is equally as important for the stems of artificial teeth. These uses, together with the platinum contact points in electric apparatus, comprise an ever increasing consumption, which will, however, be checked as the metal grows relatively dearer and thus stimulates the efforts to replace it altogether by cheaper and more accessible substitutes.

Most interesting is the statement of Professor Blake of the occurrence of platinum in the ash from certain coals in New South Wales, and the possibility of very much greater supplies at far lower figures. The following analyses of such coal are due to the courtesy of Messrs. Thirkell & Co., London, who offer to supply the coal at a price near that of the contained platinum.

ANALYSIS OF PLATINUM-VANADIUM BEARING COAL.—NO. I.

	Per cent.
Carbon	65.2
Hydrogen	4.6
Oxygen	21.8
Nitrogen	1.9
Sulphur	3.8
Water (lost at 100° C)	0.7
Ash	1.7
Total	99.7

APPROXIMATE PERCENTAGE COMPOSITION OF ASH.

	Per Cent.
Metallic Vanadium	25.1
Platinum metals	3.6
Oxygen (combined with above metals)	44.0
Sandy and other earthy matters	27.3
Total	100.0

As the coal contains 1.7 per cent. of ash, this means that it contains 0.44 per cent. of vanadium and 0.063 per cent. of platinum metals. In other words, one ton of the coal will yield 144. 16. 3 of metallic vanadium and 20. 13. 11 of platinum metals.

ANALYSIS NO. 2. SAMPLES DRAWN FROM BULK. PLATINUM-VANADIUM COAL. THE COAL CONTAINED 15 PER CENT. OF ASH.

	Percentage composition of ash.
Metallic Vanadium	2.90
Platinum Metals	0.23
Oxygen (combined with metals)	5.10
Sand, carbonate of lime, &c.	91.77
Total	100.00

The above is equal to

Oz.	Dwt.	Gr.	
146.	17.	8	vanadium in one ton of coal.
11.	13.	8	platinum metals in " "

Precious stones.—These are the object of another industry in which the domestic supply is trifling compared to the total consumption. Gems found here native are, to be sure, turned upon the market, but most of the attempts at systematic mining have shown that it is not yet possible so to direct labor as to find valuable gems in sufficient quantity to pay wages. Exceptions to this are the turquoise mines of New Mexico and the opal mines of Idaho, which promise to be permanent.

Silicified wood, found in Chalcedony Park, Arizona, is the raw material for another industry in Sioux Falls, South Dakota, where this stone is cut into slabs showing the cross sections of tree trunks set off by the brilliant coloring from iron solutions. These slabs have found much ornamental use for many fancy articles, and for clock-faces, table-tops, etc.

(*To be continued.*)

RESTRAINTS UPON THE PRACTICE OF ARCHITECTURE.

By John Beverley Robinson.

IT has recently been seriously proposed to enact various laws restricting the practice of architects upon esthetic grounds. For one thing, it has been urged that the height of all buildings in a block, or on a street, should be made uniform, to prevent the irregular appearance of differing heights. For another, the limitation of the excessive height of buildings has been asked and will probably be enacted, although this is a measure rather in the interest of adjacent proprietors than of alleged artistic importance. Again, a law has lately been enacted which provides that the societies which, from the admitted ability of their members, exercise the function of advisers in public art matters, shall have their power confirmed and their mandates enforced in New York city.

Even as a national matter, a bill has been proposed in Congress creating a National Art Commission which shall control all artistico-political work of the federal organization.

Besides these, the bill to limit competition among architects in New York by means of licenses, has been pushed of late more earnestly than ever ; and will probably before long be engraved on bronze along with the other bills of similar undying fame to protect established traders from the competition of peddlers.

It is not with the laws that are intended to limit the construction of buildings to fixed methods that this article will deal. Architects in general are so unanimously of the opinion that the clerk of a bureau surpasses them so much in honor and intelligence that they cannot get along at all without his *imprimatur* as to make it appear supererogatory to question them further on this point.

Animated by the popular admiration of those who assert a superiority of wisdom, the effort to bridle the unrestrained activity of malignly-disposed architects has gone several steps further : has been, or is about to be, extended from the regulation of constructive practice, where there is the shadow of a plea of safety to the innocent bystander, to be secured far beyond into the domain of esthetics, where no possible damage can result to anybody in spite of the absence of regulation.

The beginning has been made by the establishment here and there of various bodies which propose to exercise some kind of censorship of art, whether with or without the addition of the powers of the law.

The gentlemen composing these committees are, no doubt, men of ability,—men of refined taste and the sincerest motives. Their charges that the American people are crude in tastes and barbarous in their public adornments are also, no doubt, in the main true enough.

But their conclusion that it is well for those of refined taste to use measures to force refined designs upon the public is not the only conclusion possible.

It is quite possible that for a time the establishment of some kind of art-censorship would produce an apparent improvement in the quality of public works of art; it is the sequel that is most to be feared,—the continual growth of the idea of repression, the gradual walling-up of all the by-paths, the gradual confinement of all activities to the beaten highway, with not even a look possible over the lofty barriers, into the joyful fields of liberty on each side.

It is just as well to admit at the start that, in comparison with the older nations, America is crude. Compared with London and Paris, as far as the elegances of life are concerned, New York and Boston are of but a wild western type of civilization. We lack the records of the centuries about us; we lack the traditions of race and home; we lack the esthetic sense and critical discernment that come with high cultivation.

But, on the other hand, with the faults of youth we can hardly avoid having some of its virtues. Happy the nation that history wearies, says d'Alembert.

The crudity that comes not from innate viciousness, nor from the world-weariness of decrepitude, but from a sheer desire to accomplish great things hastily, but sufficiently, may be itself reckoned rather a virtue than a fault. Such are most of our faults,—the faults of boyishness, not of depravity. Roughness, rather than coarseness, of taste; energy in doing rather than over-delicacy in method; a desire first to gratify material needs before esthetic needs are even experienced—such are unavoidably the characteristics of a nation that is but a child among nations.

Is it possible that such traits can be changed for the better by authority imposed *ab extra?* Is it possible to force upon the undeveloped taste the pabulum that gratifies the most highly developed? Or, if it be said that it is the development of taste that is sought, is it possible to develop taste by legal compulsory methods? I speak of legal compulsory methods, because to this tend all organizations avowedly based upon a respect for authority. In so far as they abstain from appealing to the law to force their standards upon others, and rely only upon their earnest advocacy by persuasion, no reasonable man can object to them. But, for the most part, no sooner are they well established than they are bent upon "getting a bill passed" at Albany or Washington to relieve them from the labor of preaching their faith and to have it imposed willy-nilly upon the poor savages, the objects of their missionary efforts.

Thus there are now laws made, or urged upon the lawmakers, for half-a-dozen objects with which architecture has to do,—among them the law to restrict the height of buildings, and another law to make all the buildings in a row of the same height, and another to permit architects to practice at all only by license of an all-wise government bureau.

Restrictions of height are defensible, although I think hardly justifiable, on grounds of invasion of the liberty of others, as are also license regulations; when it comes to purely esthetic considerations, such as the uniformity of cornice lines, or the prohibition of all statues that are not approved by a certain committee, there is no pretence of protecting the rights of others possible. And to force objects of art upon a people too young to appreciate them, too young even to be schooled by them, is like forcing a school-boy to throw down his bat and ball and asking him to content himself with a Greek coin or a Cinquecento book cover.

The truth is that all such efforts at implanting an older civilization in unprepared soil must fail; it would be happy if failure were the only thing to be feared.

Too often the enginery of authority succeeds in its self-appointed task, crushes out crudity, and with it dash and spirit, establishes refinement, and with it the mediocrity of all school-standards.

Set up an authority of any kind to which artists must bow, even though the standard at its beginning is one which is admired by the artists themselves, and no sooner is it established than it begins to deteriorate. Outside workers, who must satisfy its criteria, cease to strive for what they really deem best, and try only to do what is known to be suited to the committee's views. Vacant seats in the committee are filled by new names in sympathy with the majority of it.

Gradually an artificial standard is erected; refined or vulgar, according to the quality of taste in the community at large; representing necessarily the average culture and enforcing average estimates of merit.

It is because the organized body represents the community that French art has retained its progressiveness, in spite of its many defects.

The French people is, upon the whole, the most advanced nation, especially in artistic matters. It has always rebelled against authority quite as effectually as the Anglo-Saxon race, although by different methods. The remnant of authoritarianism there could not exist, did it not defer to, and as much as possible embrace, the spirit of liberty that is always asserting itself in spite of the organizations.

The extraordinary part of it is that what we condemn ourselves for most severely, are precisely the things which the French critics speak well of; while what we pride ourselves upon, they treat with coolness if not contempt.

It is not our quasi-classic performances that please them. They have not a word for such clever things as the Madison Square Garden, in spite of its charm.

Originality they must have, before refinement even, so they overlook our most delicate carvings and pass beyond to commend our fifteen and twenty story office buildings, wherein, as the critics say, new problems have been met with skill and originality.

Now to erect the standard of the majority here would be to stifle growth before it has grown strong enough to live in the face of such attempts; American art, instead of working out its own salvation, by its own somewhat halting and wobbling methods, would become a mere dead tradition, imposed upon a careless and tasteless multitude by an artificial and soulless machine.

It is to be regretted that Americans have so far lost the spirit of the founders of the republic that such extensions of governmental functions are entertained at all.

The theory of a democracy is that the majority, although possessed of power to do anything it pleases, voluntarily abdicates that power, and willingly aids in establishing all possible liberty for the minority, in view of the time when the majority itself shall become a minority, and might suffer from any means of oppression that it had permitted to be erected.

In practice we find each party alternately, when it comes into power, bent upon enacting as many new laws as possible, each law requiring as many officials as possible to carry it out, which will be just so many votes to keep itself and themselves in office. Each law, besides, requires an increase of the amount of taxation, and is doubly welcome if it discovers new channels for expenditure. Every dollar spent, every board and committee appointed, every piece of special legislation enacted, means just so many more beneficiaries, so many more votes, so much heavier betting on the reëlection of the party ticket.

The process must defeat itself.

The manifest absurdities and inconsequences of our political seheme, let alone its corruption and trickery, will in the end destroy our superstitious confidence in it. We shall learn, by the saddest experience, what our brains are not big enough to teach us by *a priori* inference, that it is impossible for a majority to do anything and everything it pleases without involving us all in danger.

In the end we shall learn that the only possible function of government is the defense of the liberty of individuals; that art and science and cultivation must be slow growths, and cannot be fostered by governmental methods; and that, even if they could, the cost of indefinite increase of public expenditures becomes too great to bear, the inefficiency of indefinite increase of government bureaus too great to tolerate, the tyranny of indefinite enlargement of governmental functions too heavy for a free people to survive.

REVIEW OF THE ENGINEERING PRES

WITH A DESCRIPTIVE INDEX TO THE LEADNIG ARTICLES PUBLISHED CURRENTLY IN THE AMERICAN AND ENGLISH ENGINEERING AND ARCHITECTURAL JOURNALS.

INTRODUCTORY

THE aim in this Review and Index is, (1) to give concisely written expert reviews of those articles ‹ the month which are deemed of most importance ; (2) to supply a descriptive Index to the leadin articles published currently in the engineering, architectural and scientific press of the Unite States, Great Britain and the British Colonies; and (3) to afford, through our Clipping Bureau, a mear whereby all or any portion of this literature may be easily procured.

We hold ourselves ready to supply—usually by return mail—the full text of every article reviewed c indexed, and our charge in each case is regulated closely by the cost of a single copy of the journal fro which the article is taken.

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American Architect, The *w.* $6. Boston.
Am. Chemical Journal. *b-m.* $4. Baltimore.
Am. Engineer and Railroad Journal. *m.* $2. N.Y.
American Gas Light Journal. *w.* $3. New York.
American Geologist. *m.* $3.50. Minneapolis.
American Journal of Science. *m.* $6. New Haven.
American Journal of Sociology. *b-m.* $2 Chicago.
American Machinist. *w.* $3. New York.
American Magazine of Civics. *m.* $3. New York.
Am. Manufacturer and Iron World. *w.* $4. Pittsburg.
American Miller. *m.* $2. Chicago.
American Shipbuilder. *w.* $2. New York.
Am. Soc. of Irrigation Engineers. *qr.* $4. Denver.
Am. Soc. of Mechanical Engineers. *m.* New York.
Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
Archæologist, The. *m.* $1. Columbus, O.
Architect, The. *w.* 26*s.* London.
Architectural Record. *q.* $1. New York.
Architectural Review. *s-q.* $5. Boston.
Architecture and Building. *w.* $6. New York.
Arena, The *m.* $5. Boston.
Australian Mining Standard. *w.* 30*s.* Sydney.
Banker's Magazine. *m* $5. New York.
Banker's Magazine. *m.* 18*s.* London.
Bankers Magazine of Australia. *m.* $3. Melbourne.
Board of Trade Journal. *m.* 6s. London.
Boston Journal of Commerce. *w.* $3. Boston.
Bradstreet's. *w.* $5. New York.
Brick. *m.* $1. Chicago.
Brick Builder, The *m.* $2.50. Boston.
British Architect, The. *w.* 23*s.* 8*d.* London.
Builder, The. *w.* 26*s.* London.
Bulletin Am. Geographical Soc. *q.* $5. New York
Bulletin Am. Iron and Steel Asso. *w.* $4. Phila
Bulletin of the Univ. of Wisconsin. Madison.
California Architect. *m.* $3. San Francisco.
Canadian Architect. *m.* $2. Toronto.
Canadian Electrical News. *m.* $1. Toronto.
Canadian Engineer. *m.* $1. Montreal.
Canadian Mining Review. *m.* $1.50. Ottawa.
Century Magazine. *m.* $4. New York.
Chautauquan, The *m.* $2. Meadville, Pa.
Clay Record. *s-m.* $1. Chicago.
Colliery Engineer. *m.* $2. Scranton, Pa.
Colliery Guardian. *w.* 27*s.* 6*d.* London.
Compressed Air. *m.* $1. New York.
Contemporary Review. *m.* $4.50. London
Cosmopolitan, The *m.* $1.20. New York.
Domestic Engineering. *m.* $2. Chicago.
Electric Power. *m.* $2. New York.
Electric Railway Gazette. *w.* $3. New York.
Electrical Age. *w.* $3. New York.

Electrical Engineer. *w.* 19*s.* 6*d.* London.
Electrical Engineer. *w.* $3. New York
Electrical Engineering. *m.* $1. Chicago.
Electrical Industries. *m.* $1. Chicago.
Electrical Plant. *m.* 6*s.* London.
Electrical Review. *w.* 21*s.* 8*d.* London.
Electrical Review. *w.* $3. New York.
Electrical World. *w.* $3. New York.
Electrician. *w.* 24*s.* London.
Electricity. *w.* $2.50. New York.
Electricity. *w.* 7*s.* 6*d.* London.
Engineer, The. *s-m.* $2.50. New York.
Engineer, The. *w.* 36*s.* London.
Engineer & Contractor. *w.* $1. San Francisco.
Engineers' Gazette. *m.* 8*s* London.
Engineering. *w.* 36*s.* London.
Engineering and Mining Journal. *w.* $5. N. Y
Engineering Magazine. *m.* $3. New York
Engineering-Mechanics. *m.* $2. Phila.
Engineering News. *w.* $5. New York.
Engineering Record. *w.* $5. New York.
Engineering Review. *m.* 7*s.* London.
Eng. Soc. of the School of Prac. Sci. Toronto.
Eng. Soc. of Western Penn'a. *m.* $7. Pittsburg.
Fairplay. *w.* 32*s.* 6*d.* London.
Fire and Water. *w.* $3. New York.
Forester, The. *bi-m.* 50 cts. May's Landing, N.J
Fortnightly Review. *m.* $4.50. London.
Forum, The. *m.* $3. New York.
Foundry, The. *m.* $1. Detroit.
Garden and Forest. *w.* $4. New York.
Gas Engineers' Mag. *m.* 6*s.* 6*d.* Birmingham.
Gas World, The. *w.* 13*s.* London.
Geological Magazine, The. *m.* 18s. London.
Gunton's Magazine. *m.* $2. New York.
Heating and Ventilation. *m.* $1. New York.
Ill. Carpenter and Builder. *w.* 8*s.* 8*d.* London.
Improvement Bulletin. *w.* $5. Minneapolis.
India Rubber World. *m.* $3. New York
Indian and Eastern Engineer. *w.* 20 Rs. Calcutta.
Indian Engineering. *w.* 18 Rs. Calcutta.
Industries and Iron. *w.* £1. London.
Inland Architect. *m.* $5. Chicago.
Inventive Age. *s-m.* $1. Washington.
Iron Age, The. *w.* $4.50. New York.
Iron and Coal Trade Review. *w.* 30*s.* 4*d.* London
Iron & Steel Trades' Journal. *w.* 25*s.* London
Iron Industries Gazette. *m.* $1.50. Buffalo.
Iron Trade Review. *w.* $3. Cleveland
Journal Am Chemical Soc. *m.* $5. Easton
Jour. Am. Soc. Naval Engineers. *qr.* $5. Wash
Journal Assoc. Eng. Society. *m.* $3. St. Louis.
Journal of Electricity, The *m.* $1. San Francisco.
Journal Franklin Institute. *m.* $5. Phila
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q.* $2. New London.
Journal Political Economy. *q.* $3. Chicago.
Journal Royal Inst. of Brit. Arch. *s-q.* 6*s.* London
Journal of the Society of Arts. *w.* London.
Journal of the Western Society of Engineers. *b-m.* $2. Chicago.
Locomotive Engineering. *m.* $2. New York.
Lord's Magazine. *m.* $1. Boston.
Machinery *m.* $1. New York.
Machinery. *m.* 9*s.* London.
Manufacturer and Builder. *m.* $1.50. New York.
Manufacturer's Record. *w.* $4. Baltimore.
Marine Engineer. *m.* 7*s.* 6*d.* London.
Master Steam Fitter. *m.* $1. Chicago.
McClure's Magazine. *m* $1. New York.
Mechanical World. *w.* 8*s.* 8*d.* London.
Metal Worker. *w.* $2. New York.
Milling. *m.* $2. Chicago.
Mining, *m* $1. Spokane.
Mining and Sci. Press. *w.* $3. San Francisco
Mining Industry and Review. *w.* $2. Denver
Mining Journal, The. *w.* £1. 8*s.* London.
Mining World, The. *w.* 21*s.* London.
National Builder. *m.* $3. Chicago.
Nature. *w.* $7. London.
New Science Review, The. *qr.* $2. New York.
Nineteenth Century. *m.* $4.50 London
North American Review. *m.* $5. New York.
Overland Monthly. *m.* $3. San Francisco.
Paving & Munic. Eng. *m.* $2. Indianapolis.
Physical Review, The. *b-m.* $3. New York.
Plumber and Decorator. *m.* 6*s.* 6*d.* London
Popular Science Monthly. *m.* $5. New York
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Practical Engineer. *w.* 10*s.* London.
Proceedings Engineer's Club. *q.* $2. Phila.
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Progress of the World, The. *m.* $1. N. Y.
Railroad Car Journal. *m.* $1. New York.
Railroad Gazette. *w.* $4.20. New York.
Railway Age. *w.* $4. Chicago.
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Railway Press, The. *m.* 7*s.* London.
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Railway World. *m.* 5*s.* London.
Review of Reviews. *m.* $2.50. New York.
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Sanitarian. *m* $4. Brooklyn.
Sanitary Plumber. *s-m.* $2. New York.
Sanitary Record. *m.* 10*s.* London.
School of Mines Quarterly. $2. New York.
Science *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York
Scientific Am. Supplement. *w.* $5. New York
Scientific Machinist. *s-m.* $1.50. Cleveland, O
Scientific Quarterly *q.* $2. Golden, Col
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Journal of Eng. *m.* $2. Ithaca, N. Y.
Southern Architect. *m.* $2. Atlanta
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago.
Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn
Trans. Am. Ins. Electrical Eng. *m.* $5. N Y.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* $10. New York
Transport. *w.* £1. 5*s.* London.
Western Electrician. *w.* $3. Chicago.
Western Mining World. *w.* $4. Butte, Mon.
Western Railway Club, Pro. Chicago.
Yale Scientific Monthly, The. *m.* $2.50 New Haven.

ARCHITECTURE & BUILDING

See also "Civil Engineering" and "Domestic Engineering."

Is the High Building Doomed?

An impartial observer, if called to point out the most notable architectural development of our time, would unhesitatingly select the high building as illustrating the most marked form of modern architectural ingenuity. And, if the same person were asked to point out the most remarkable feature in connection with these mammoth structures, he would unquestionably choose the clamor that architects, throughout this land of high buildings, are making for their extinction. Of course, every one, except the architects, knows that most of those who design high buildings have not the slightest idea how to set about this task. And it is further evident that many of the most recent designs are quite as bad as the earliest. A stoppage in the erection of high buildings would give us a breathing spell; those gentlemen now engaged in the high building business without understanding it might find other means of utilizing their energies; still, the extraordinary demand of the architects that there shall be no more high buildings must rank among the sensational psychological phenomena of our time.

Of the quantity of letters, articles, notes, comments, and utterances of all sorts that have been put forth during this controversy there is not much of real value. The stock arguments of the anti-high-buildingists do not differ much one from the other, and, as a very large number of busy-bodies have concerned themselves in this matter, there has been a great deal said over and over again without much point and certainly without many facts on which tenable opinions could be supported. Fire-chiefs who have no hose that reaches to the top of a twenty-story building; architects incapable of thinking vertically, because their academic training has been horizontal; real-estate owners who wish no more rivals to their own lofty buildings; newspapers that already occupy gigantic structures on open spaces; ladies who are not business women and therefore do not understand the commercial values of high buildings; public men who know nothing of architecture, but repeat what is told to them; all sorts of people who know nothing about the constructive and economic conditions of high building,—these are the people who are making the uproar, and endeavoring to put a stop to the further development of one of the most characteristic, useful, and important phases of American architecture. That is what the anti-high-building agitation really amounts to.

Amid the mass of literature the antis have put out it is a pleasure to read so sober, unbiased, reasonable, and interesting a discussion of the whole problem as Mr. C. H. Blackhall has contributed to the February number of *The Brickbuilder*. He sums up the matter very admirably:

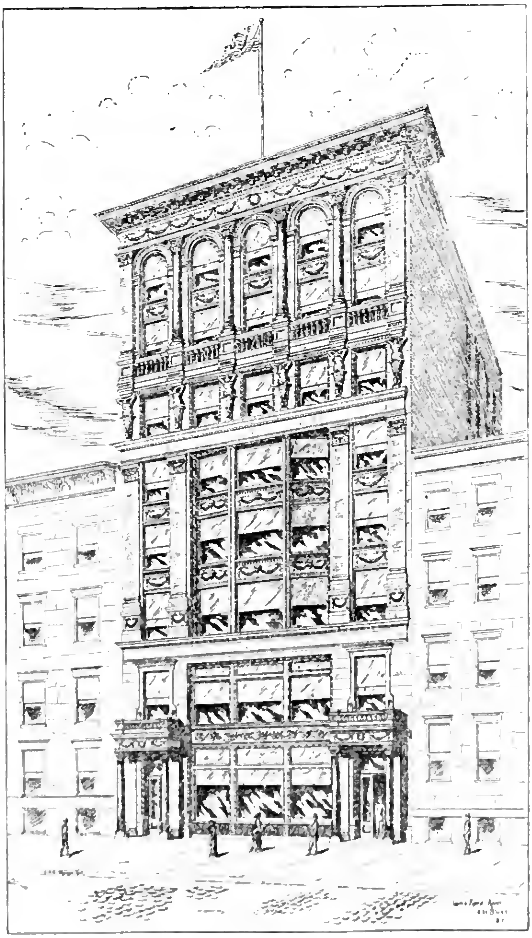
"From a business standpoint, no one can question the desirability of concentration, and this the sky-scraper does most effectually. People may grumble at the shadows cast by the huge structures, and may even, collectively, say that they ought not to be tolerated or allowed; but they answer a public necessity. The best commercial warrant for their being is afforded by the manner in which they rent, and we have only to look at the experience of nearly all the tall buildings which have been erected to see that, however much they may be objected to in theory, as a matter of fact the top offices are the ones rented first, those nearest the ground bring the most money, and the ones which pay the least are midway, or at about the height of what we used to call tall buildings a few years ago. The possibilities of these buildings have so enormously increased the earning capacity of the land that property which would hardly carry itself in former times on a valuation of one hundred dollars per foot can now be made to yield a handsome surplus on a valuation of three hundred dollars, while modern machinery and business methods have made it possible to erect these excessively tall structures at a less price per cubic foot than was the rule a few years ago with buildings running up only eighty or ninety feet.

"I believe in the high building; I believe in it architecturally, structurally, and esthetically, when it is properly placed and designed; and I cannot believe the high building need be condemned as such. Very few of our tall office-buildings are in accord with their locations and surroundings, but this is more due to the selfishness of the owners of high-cost land than real lack of appreciation by the architects. We do not need to reduce the height of buildings, but, rather, we want to reform the public taste and the greed of capitalists, so that we will design our tall buildings as monuments, and not as mere money-mills. We want high buildings. It is impossible, under existing conditions, to carry on business in the structures which our fathers found sufficient to their wants. Ten stories is not enough for modern commercial needs, and I will not believe that the possibilities of architecture are so barren that a way cannot be found to carry up our buildings twenty or thirty stories, if necessary, without sacrificing the unity which ought to prevail in a well-regulated city."

The Architectural League Exhibition.

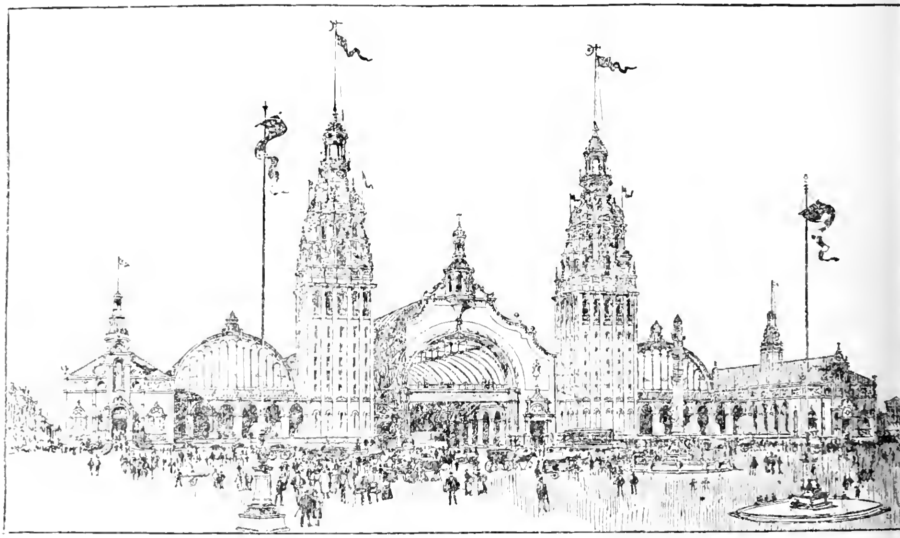
FROM its situation in New York the annual exhibition of the Architectural League of this city has come to be the most important event of its kind in America. Though most of the technical journals print reviews of it, it happens that the most scholarly and thorough are printed in a New York daily paper, the *Evening Post*, which retains on its staff one of the most competent architectural writers of the day.

The recent exhibition of the League suffers, as all its preceding exhibitions have suffered, from the intrusion of decorative designs, examples of fabrics, sculpture, and odds and ends of all sorts, all more or less directly connected with architecture, many of them of some artistic interest, but given an exaggerated position in the galleries, and certainly consuming space that might more properly have been given to architectural drawings. As it is, the space actually given to architecture seems less than that given to the other exhibits. More than once this magazine has pointed out the decorative effect of many of the drawings in the League's exhibitions, which, in previous years, seemed more like a collection of water-colors than an



THE CORN BUILDING, NEW YORK.
Louis Corn, Architect.
[From Architecture and Building.]

exhibit of sober architectural drawings. It is a pleasure to note, this year, a reaction against the evils of the earlier system, and it may safely be said that never before did the League show so many drawings that not only represented architectural subjects, but were real architectural drawings. An arrangement of the drawings in alcoves was also an excellent innovation, as were the memorial alcoves set apart for the work of some recently-deceased architects. In themselves these memorial exhibits were scarcely ample enough to do justice to their subjects, but the attempt at a systematic exhibit which they indicated foreshadows better things for the future.



PROPOSED NEW MARKET, ST. LOUIS, MO. LOUIS MULLGARDT, ARCHITECT.

[From the Inland Architect.]

Perhaps the most striking thing in connection with this exhibition was the relatively small number of small works. The "great" architects were represented in fine force, though it is true enough that some of their designs were not worthy of the reputation of their makers. But the small cottage, the average city house, the unimportant things that make up the bulk of the average architect's work, and by which most architects live, were by no means so numerous as in previous years. It could not have been that such things were not offered; there has been no falling off in building to account for a sudd cessation of this work. It would see, rather, that the desire of the modern chitects to associate their names w some one great building has driven th to concentrate their energies on work monumental description when possib. This, of course, is one of the results Frenchitizing American architecture. better result, and much more valuable, the tendency towards architectural dra- ings. True, the public does not understa working drawings, and perhaps pref pretty little water-colors; but the arc- tectural drawing is necessarily more less technical, and such drawings have t first place in such exhibitions. T League's show was unusually strong this—perhaps its most notable—feature

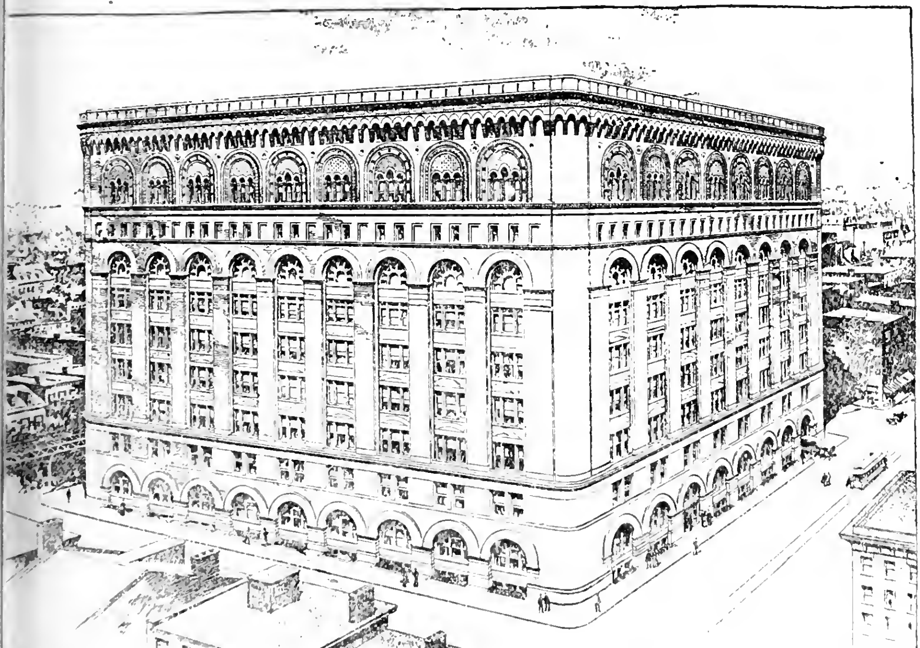
Unfortunately it is quite impossible look in any of our annual architectu exhibitions for a general review and su- mary of the architecture of the year. Th they should contain such is very clear, a it is equally evident that this could readily accomplished, if the archite were to take a proper interest.

Illustrations of the Month.

AMONG the illustrations of the mor none exhibits such an extraordinary

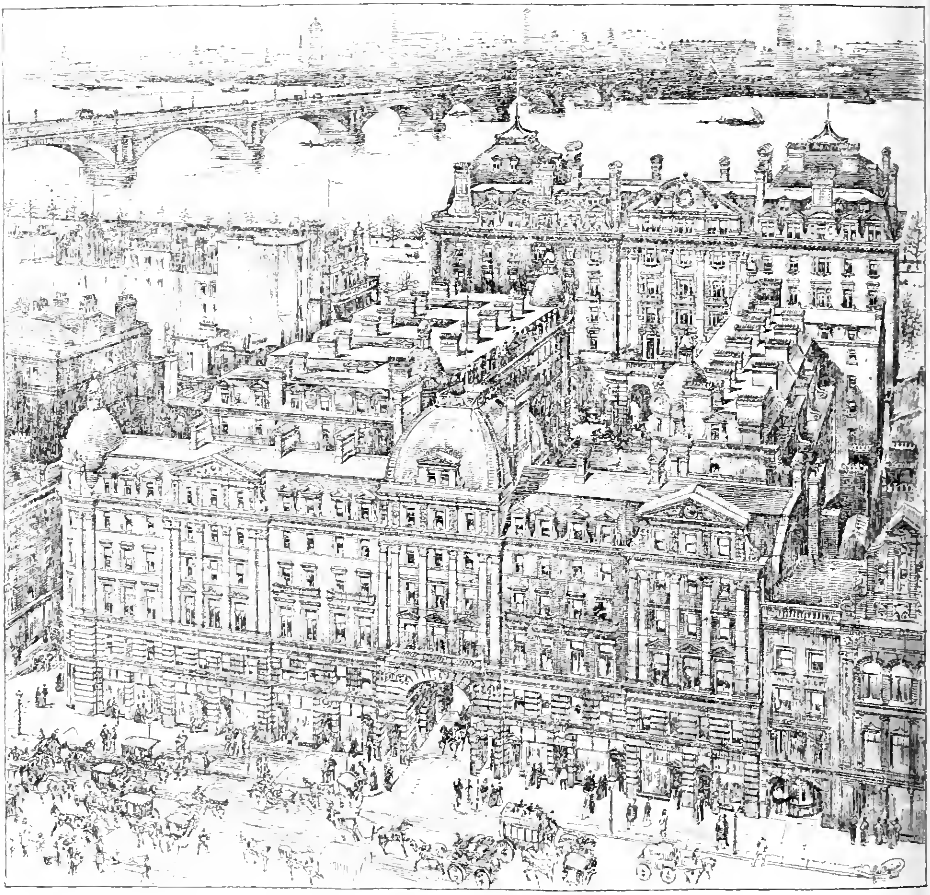
:ture from proper architectural ideas as : Corn Building in New York, of which illustration is reproduced in these pages a type of what to avoid. The dimen-ns are moderate, tolerably wide, and t exaggerated in height. Of the base the design nothing need be said other an that it is commonplace. The second :tion is made as it is, apparently because author did not know what to do with ; space; the bow window recessed within e building line is a most unhappy con-it that has some vogue at this time in ildings of this class. Above is a single ory with gaines between the windows, either a frieze nor a crowning member, r there are two more above it; possibly has been interjected here because these gures could be had at a reduction by the alf dozen. At all events, it is entirely un-:lated to any other part of the building, d this idea of independence, once intro-uced, seems to have taken possession of e designer, for the two topmost stories e as unrelated to the lower portions as ough they were located on another ilding. It sometimes happens in archi-ctural practice that the material employed in the beginning of a building is changed for a cheaper substance in the higher stories. The present structure is hardly intelligible save on the ground that different designers were employed in the different parts. Possibly it was composed something in the manner of the composite tales one hears of now-a-days.

The new Appraisers' Warehouse in New York, designed in the office of the supervising architect, is a featureless design, yet showing some attempt to conform to the canons of commercial building in being treated with a basement, a superstructure, and a frieze. Its chief merit is its commonplaceness, a not inconsiderable item, since many of the designs of the same origin are most aggressive. In the present instance everything is so hard and cold, so unfeeling, as well as commonplace, that even the additional merit of negativeness is denied to it.



PPRAISERS' WAREHOUSE, N Y. WM. MARTIN AIKEN, SUPERVISING ARCHITECT, WASHINGTON, D. C.

The *Inland Architect* for March prints, among its photogravure plates, some illustrations of three important office-buildings in Chicago, which are the more interesting from the fact that rarely are any interior portions of our great office-buildings reproduced in the architectural papers. It also publishes some charming photographs of details from the Guaranty Building, at Buffalo, by Mr. Louis H. Sullivan, whose very great power as a designer, and mastery of form, show constant growth with each fresh undertaking. The photographs in this number are hard and unsatisfactory; their mechanical defects, however, are more than compensated for by the interest of their subjects. It is impossible to criticise the proposed new market for St. Louis, Mo., which is reproduced herewith from this journal, without the aid of a plan. The utility of the two large towers is not apparent, and, apart from these, the design appears burdened with rather more decorative detail than is required in such a structure.



THE HOTEL CECIL, LONDON. PERRY & REED, ARCHITECTS.
[From the British Architect.]

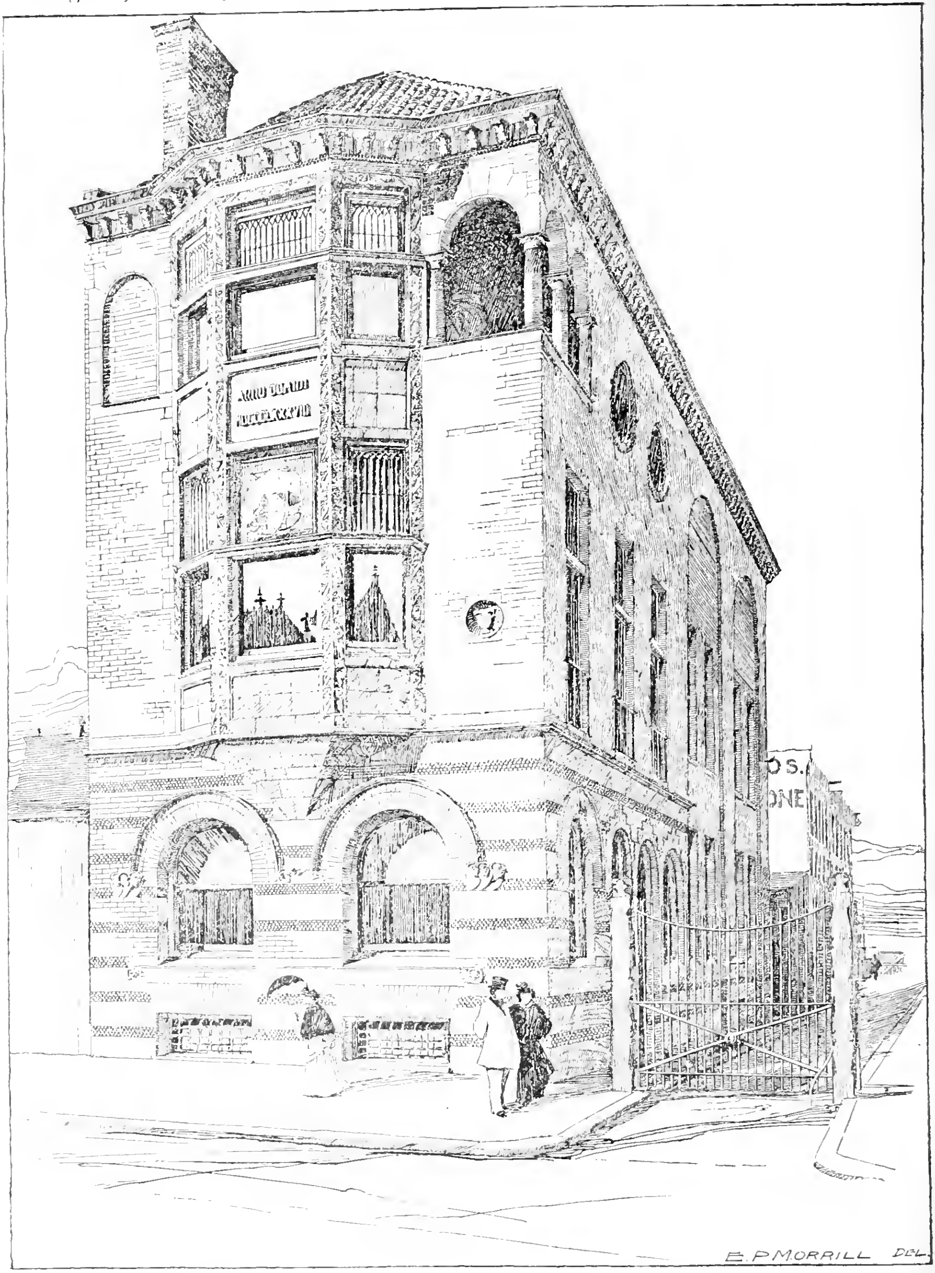
The *Builder* publishes no plates of the first importance this month. The competition design for the Durham Municipal Buildings by Mr. A. T. Bolton and Mr. A. N. Prentice is interesting, genuinely English, and of much originality. Mr. John Belcher contributes an interior and exterior competition design for the Royal Insurance Buildings, Liverpool. It is a most elaborate design with much decorative sculpture. Mr. Belcher has shown great originality in his Renaissance designs, and it need hardly be said, therefore, that this is not the cold, formal copying of classic detail which a Renaissance bank design by an American architect would be. It is in the general style of the design for the South Kensington Museum made by this architect; it does not show, therefore, an advance on the strong originality displayed in his Institute of Chartered Accountants in London.

Quite in contrast to this is a general store building in Edinburgh, of which several photographs are published in *The Architect*. Above a high ground-floor are four stories, each with a separate Order applied in coupled columns between the windows and at the end of each section of the very varied fronts. The roof line is exceedingly complicated, with high dormers and a low octagonal tower on the corner. It is impossible to describe the unrest of this design, and it certainly is not kind to the spectator to say that it must be seen to be appreciated. Among the photographic plates of this journal are some college buildings at Leeds from designs by Mr. Waterhouse and Mr. W. H. Thorp. Both are in a formal Gothic, with little of the poetry of the style. An interior Hexagon by the latter architect is, however, of considerable interest and well studied.

Recent visitors to London have observed, on the Victoria Embankment, a huge structure which has long rejoiced in the distinction of being one of the least satisfactory examples of modern English building and the loftiest commercial structure in the British metropolis. Its origin was due to Jabez Balfour, of unsavory reputation, and for several years was incomplete and unused. This has now been converted into a vast hotel, with many substantial additions; and some illustrations in *The British Architect*, one of which is reproduced herewith, show its present form. The Bible Training Institute in Glasgow, published in the same journal, is an unsuccessful effort in "modern" Romanesque,—a style that, in America, has now almost archaic interest, so rapidly have we moved away from it.

ROBERT GOULD SHAW GRAMMAR SCHOOL, BOSTON, MASS. EDMUND M. WHEELWRIGHT, ARCHITECT.
[From the Brickbuilder.]

The most interesting photographs in *Architecture and Building* illustrate the new Wool Exchange Building in New York by Mr. W. B. Tubby, a strong, plain design, admirably in keeping with the character of the structure as a wool warehouse, and yet showing, within very restricted limits, the genuine character that the true architect can give to the simplest forms. A residence for W. W. Sherman on Fifth avenue, New York, suffers from the circumstance that the two lower stories are of totally different design and material from the three upper. In a building of such a moderate height, and especially a residence, so sharp a demarcation in parts is neither necessary or desirable. A competitive design for an armory in New York is one of those extraordinary efforts in imaginary military architecture that appears to have been arbitrarily settled upon as the type of such buildings, though few of them are of any real merit. The present example is no exception to the rule. This journal also publishes a useful plate of details of Congress Hall in Philadelphia, by Mr. G. C. Mason. The



ST. ANTHONY'S CLUB, PHILADELPHIA. WILSON EYRE, JR., ARCHITECT.

[From American Architect.]

St. Nicholas Skating Rink, the newest place of amusement in New York, is illustrated with tolerable fulness.

The *American Architect* continues its superb series of American city club-houses, with some additional gelatine plates of the Metropolitan Club in New York and the Army and Navy Club House in Washington. Some of the plates of the former are a little too black in the dark places, but they are fine illustrations of the elaborate interior. The Army and Navy Club is a much less pretentious building, with a severe exterior not only unpleasing, but unexpressive of the purposes of the structure. In charming contrast is St. Anthony's Club in Philadelphia, by Mr. Wilson Eyre, Jr., which is reproduced in our pages. It is a charming design, full of that poetic feeling which Mr. Eyre long ago taught us to expect in his buildings. The closed panel on the left in the upper story, which corresponds to the loggia on the other corner, is, however, a concession to symmetry not usually shown in the work of this architect.

E. D. Chamberlain's Building in St. Paul, Minn., by Mr. Cass Gilbert, is a not very successful attempt to adapt the Renaissance style to the requirements of commercial design. The wide spacing in the lower stories is too suggestive of the steel girders that support the elaborately detailed crowning story. On the other hand, we may be sure that a drawing of the Musée at Nantes, by M. C. Josso, will be hailed with joy and the utmost satisfaction by the Frenchites. It is an admirably studied design of great beauty, and, if carried out, will be entitled to rank among the most notable recent buildings in France. One does not need to be a Frenchite to enjoy a drawing like this; but it will be a quite different thing when we see it reproduced in some of the paper exercises by these devotees of French art in America.

The same journal prints a gelatine plate of the Chicago Academy of Sciences by Patton & Fisher, of which the main feature is the inevitable classic portico, this time with Corinthian columns. Even when this has been lifted up above a basement and sub-basement, it has been found impossible to avoid a considerable flight of external steps. A well-studied design for a Methodist church in Philadelphia is contributed by Mr. G. T. Pierson. Among the other illustrations mention may be made of a couple of sheets of foreign sketches by a Rotch Travelling Scholar. These are light line sketches, usual in work from this source; interesting enough in a way, yet quite without that value which comes from systematic measured work. It is a matter of regret, with the hordes of architectural students annually let loose upon Europe from this country, that more systematic and well-organized work is not undertaken by them. So much remains to be done in this direction that it is an especial pity that the field should be neglected.

The *Brickbuilder* for March gives up its plates to illustrations of schools in Boston by Mr. E. M. Wheelwright. They are admirable types of the class of buildings of which this accomplished architect has made himself a thorough master, and well deserve more attentive study than can be given them in this review.

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†4748. The Glass Mosaics at St. Paul's. Harry J. Powell (A very interesting experiment in decoration which is being worked out by Prof. Richmond in the choir of St. Paul's Cathedral. Much information regarding mosaics is also given). Contemporary Rev-March. 3500 w.

4798. Restoration of Congress Hall, Philadelphia. George C. Mason (The article is intended to give a brief description of the building and the restorations now in progress). Arch & Build. March 14. 4000 w.

4799. Master Builders' Association (Boston) (Abstract of a circular issued by this association with reference to the bill before the Mass. legislature to consolidate certain city departments). Arch & Build-March 14. 1800 w.

*4800. Saint Front of Périgueux, and the Domed Churches of Périgord and La Charente. R. Phené Spiers (Full paper read at the general meeting of the Roy. Inst. of British Arch., with discussion and illustrations). Jour of Roy Inst of Brit Arch-Feb. 20. 13000 w.

*4801. Traceries, and Their Position in Architectural Design. William Searle Hicks (Read before the Northern Association. The principles are given as (1) natural suggestions; (2) geometrical and symmetrical dispositions; (3) varied repetitions; (4) simple subordinations; (5) balance of parts; (6) contrast of lines; (7) refinement of outlines; (8) delicacy or lightness of structure; (9) intricacy of convolutions or of interlacings). Jour Roy Inst of Brit Arch-Feb. 20. 4800 w.

*4812. Electricity in Connection with Building. W. H. Preece (The first part is merely introductory). Elec Eng, Lond-March 6. Serial. 1st part. 900 w.

*4816. M'Ewan Hall of the Edinburgh University (A description of the building given by W. M'Ewan to the University of Edinburgh). Arch, Lond-March 6. 2800 w.

*4818. New Streets: Architecturally Considered (Editorial considering the principal difficulties in laying out new streets in old cities; the different methods proposed are discussed, and the relation of the architecture to the street). Builder-March 7. 3500 w.

*4819. Romanesque Architecture. Ill. Prof. Aitchison (The fifth Royal Acad. Lecture on Architecture this session). Builder-March 7. 4000 w.

*4849. Hotel Cecil, London, England. Arthur Lee (Illustrated description of a fine hotel recently built upon the Thames embankment). Stone-March. 400 w.

4870. The Westfield, N. J., Bank Building (Illustrated description). Eng Rec-March 14. 800 w.

4896. Architecture and Engineering. A. D. F. Hamlin (An address delivered before the Architectural League of New York. Setting forth some of the elements which distinguish architecture from building and engineering, and discussing its relations to the science and profession of engineering, etc). Eng Rec-March 21. Serial. 1st part. 3000 w.

4903. United States Public Buildings Commission. A. F. Tennille (Bill recommended with view to securing better methods and to give the country a better type of architecture in its public buildings). Arch & Build-March 21. 2700 w.

*4943. Romanesque Architecture. Prof. Aitchison (The sixth and last Royal Academy

Lecture on Architecture this session). Builder–March 14. 5000 w.

*4944. Domestic Architecture. Grant Helliwell (Considered in its general and also its specific aspect). Can Arch–March. 3000 w.

*4945. Building Stones of Eastern Ontario. Andrew Bell (Read before the Ontario Assn. of Architects. Notes on the building stones found in eastern Ontario and lower Ottawa valley, embracing that part of the province and Ottawa valley east of a line from the head of the Bay of Quinte to Mattawa, on the Ottawa). Can Arch–March. 3000 w.

*4946. The Historical Buildings in the Hungarian Millennial Exhibition (Illustrated description of the buildings of the great national exhibition to be opened at Budapest on May 2. These buildings are intended to represent the political and intellectual life through which the country has passed during ten centuries of time). Arch, Lond–March 13. 1100 w.

*4947. Masonry. Hervey Flint (Read at meeting of the Arch. Assn., England. A lecture on practical stone work, exterior and interior). Arch, Lond–March 13. 5800 w.

*5003. The Brick Architecture of Holland. R. Clipston Sturgis (The brick work of the public buildings, secular and ecclesiastical, is to be considered and illustrated). Br Build–March. 1200 w.

*5004. The Architect and Contractor. Thomas A. Fox (Introduction to a series of papers that will deal with the problems growing out of the new conditions and requirements in architecture. The next paper will consider the relations between the architect and the contractor). Br Build–March. Serial. 1st part. 800 w.

*5005. Brick Archings (How to build a brick arch. Two methods considered). Br Build–March. 1000 w.

*5013. Clacton-on-Sea Pier and Pavilion (Illustrated description) Engng–March 20. 2000 w.

5039. New Library Building, University of the City of New York (Illustration showing the main features of plan and arrangement of the new building, with brief description). Eng Rec–March 28. 200 w.

*5054. Church Architecture in Scotland During the Past Century. John Honeyman (Abstracts from a lecture given before the architectural section of the Glasgow Phil. Soc). Brit Arch–March 20. 1100 w.

*5055. Electricity Connected with Building. W. H. Preece (A lecture with the purpose of showing how electricity can aid in supplying pure air, pure water, pure food, warmth, light, and the things needed to maintain health). Arch, Lond–March 20. 3000 w.

*5056. Stamboul : Old and New. Richard Davey (A paper read before the foreign and colonial section of the Society of Arts. Interesting impressions of a traveller). Arch, Lond–March 20. Serial. 1st part. 1500 w.

5065. Making Terra-Cotta—Enameled Terra Cotta Fronts for the Steel Sky-Scraper Buildings (Describes the making of terra-cotta, and refers to its rapid growing use as an architectural material, predicting its future popularity). Clay Rec–March 28. 1500 w.

†5073. The Churches of Perigueux and Angouleme. M. G. Van Rensselaer (Illustrated description of these churches, written in popular style, and most interestingly tracing their influence upon architecture). Cent Mag–April. 8500 w.

*5128. Notes on Some Remnants of Mediæval Burgundy. Percy Scott Worthington (Read before the Allied Societies of England. Dealing with some of the prominent architectural features, not only in what is now known as Burgundy, but all the country in France or Switzerland subjected to Burgundian influences). Jour Roy Inst of Brit Arch–March 5. 4300 w.

*5129. Some Observations on Ancient and Modern Building. Arthur Dixon (The comparison of the architecture of ancient times with that of the present century, with a view to discovering why the more ancient impresses students as more beautiful). Jour Roy Inst of Brit Arch–March 5. 2800 w.

5135. The Tennessee Centennial Exposition (Brief description of the buildings with illustrations of the work thus far accomplished). Tradesman–April 1. 700 w.

5137. Civil Service Examination for Building Inspectors (The questions of technical character used at the late examinations for building inspectors, both for iron and steel work and for the general inspection of buildings). Arch & Build–April 4. 1800 w.

5189. Tile Roofing. Max A. Th. Boehncke (An illustrated description of the manufacture and use of the cheapest kind of tile roofs, which have done very good service in Europe for centuries). Brick–April. 1800 w.

*5190. Failure of Buildings. Roger Smith (A lecture delivered in Carpenter's Hall, England. Considering why buildings fail and, to some extent how they fail). Arch, Lond–March 27. Serial. 1st part. 5500 w.

*5194. Concerning Things American. (Editorial review of the Catalogue of the Eleventh Exhibition of the Architectural League). Builder–March 28. 3000 w.

*5195. The Architecture of the Teutonic Order, with special reference to the Restoration of the Marienburg. C. Fitz Roy Doll (A paper read at the Architectural Association, London, with discussion). Builder–March 28. 8000 w.

*5196. The Steeple of St. Nicholas, Newcastle on-Tyne. From the *Newcastle Daily Leader* (Its history and the work of repair). Brit Arch–March 27. 1500 w.

5248. Foundations of the Meyer-Jonasson Building. (Illustrated description of the construction of piers founded on the rock by the use of caissons, sunk by the water process; the building is situated at Broadway and Twelfth Sts., New York. A difficult piece of work). Eng Rec–April 4. 2500 w.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

The Life of Iron Railway Bridges.

THE editor of *The Engineer* (London, Feb. 14) touches upon this subject in a very interesting manner, showing how the increased demands of traffic have increased the weight of both locomotive and cars. The same bridge now carries an eighty-ton locomotive which was designed for a fifty-four-ton engine, and thus there has been repeated reinforcing and patching of girders at their weaker points. This has not made the bridge of adequate capacity in all cases, and is not liable to do so where bridges have been correctly proportioned. The editor states that the American roads possess too many of these old bridges for public safety, and continues :

"It is comparatively a very simple matter to ascertain if a bridge is quite safe, and equally so to discover if it is quite dangerous, but to determine the line of demarcation exactly where safety terminates and danger commences is frequently a difficult, delicate, and anxious investigation. It is, moreover, one which cannot be left altogether, as a rule, to the judgment of any one particular character or class of mind. The pure theorist would point to his calculations and figures, and unhesitatingly predict the certain collapse of the structure, if the actual stresses exceeded those he had allowed and provided for. As a matter of fact, experience and practice belie this theoretical assertion on nearly every railway in the world. Again, a simple practical man in the capacity of an inspector might detect some sl ght deformation in some one member of a truss, and honestly conclude that the bridge was in a dangerous condition ; whereas the defect might be of no consequence whatever, and the bridge in a perfectly secure state. In order to arrive at a competent opinion respecting this apparently evenly-balanced question, a searching and rigorous inspection and examination of the existing structure is, in the first place, imperative. Secondly, the ultimate decision must be founded, in addition, upon an accurate knowledge of the amount and character of the stresses upon it originally provided for, and of those subsequently imposed. Thirdly, these two sources of information must be supplemented by a perfect acquaintance with the particular type of girder or truss under investigation, with the quality of the material and workmanship, and with the amount of the maintenance or negligence, as it may happen to be, which has attended the bridge since its erection. A certain amount of practical experience and ability in dealing with the subject must also be possessed by the official upon whose fiat depends the possibly fatal prolongation of the life of an already dangerous structure, or the condemnation of one which has still some years of useful duty before it.

"It is a matter for regret in connection with the subject of our article that tubular bridges are now obsolete ; box girders, except under especial conditions, are in the same category ; and plate girders rarely available beyond the moderate span of a couple of hundred feet. All these varieties of the continuous web type have afforded the best record for longevity, and to them may be added riveted lattice girders with several, but not too many, systems or series of triangulations. There are numerous examples of bridges belonging to one or other of these examples in our own country which have far surpassed the quarter of a century allotted to them,—the Menai bridge, for instance. One reason assigned for their superior durability is that the stresses due to both the dead and live loads, as well as to that inseparable but indeterminate function of the latter termed impact, are more uniformly diffused over a larger portion of the main girders, instead of being concentrated, or, perhaps, preferably speaking, located over a comparatively few points. In the former case, the whole bridge resists *en masse*, as it were, the impact of the rapidly-moving load, while in the latter the effect of the shock has to be counteracted by a very short length of the girders; for it is an axiom that the dynamical effect of a moving load decreases as the separate members of the girders are more remote from those which constitute the locus of its application.

"While it is no doubt both the duty and interest of the engineer to prolong the life of his bridges,—that is, to make them last as long as possible,—the safety of the public is paramount to all other considerations. Iron and steel are cheap in comparison with human limbs and lives."

Welded Steel Mains and Joints.

THE necessity of a light-weight pipe which can be readily put together in isolated localities has developed the steel-pipe business amazingly in the past twenty years. The seams in the steel-pipes were first riveted, but are now welded, and the methods employed in joining these welded sections have been very ably set forth in a paper before the Manchester (England) Association of Engineers by Mr. J. G. Stewart. The following is abstracted from the lecture as printed in *Industries and Iron* (Feb. 28):

"The form of joint to be used for connecting steel pipes together depends upon whether the joint is to be permanent or temporary, and also upon the pressure and the nature of the stresses to which the joint is to be subjected. If the stress to be borne is simply pressure, tending to blow the pipes apart, the designing of the joint is comparatively simplified; but generally there is a bending action, due to the pipes not being supported continuously along the line, to unequal temperature of parts of the pipe, and to shocks and vibration. These latter conditions prevail more or less in all cases of steam pipes. A light and simple form of flange joint suitable for the most moderate pressure is made by bulging and turning over the end of the pipe to form the flange (Fig. 1). It is, of course, apparent that the metal of the pipe is much too thin to form a proper flange, unless thickened up very considerably before or after being turned over, as it forms an unstayed thin surface between the bolts. A flat ring has been put behind for the purpose of helping this thin flange, but a better form of joint may be made by fitting a ring of stamped angle steel behind the turned-over flange, which makes the joint much stronger (Fig. 2). It has, however, the disadvantage of having nothing to hold in the jointing material, which, in the course of time, owing to cooling and heating, probably creeps a little, and is soon afterwards blown out. To obviate this, the cast-steel flange has been made similar to the stamped steel, but with a bored-out recess in the face of one of the flanges which holds the two small turned-over flanges and the jointing material in. The jointing material is thus securely held in (Fig. 3).

"This type of flange can also be made in two parts, which are cast with projections and recesses dovetailing together when fixed in position, and, when bolted up, held as securely as if the flanges were solid. The principal advantage of this arrangement is to enable the flanges to be shipped separately from the pipes.

"It is sometimes an advantage, or a necessity, to have the flange firmly fixed to the pipe; riveting on of flanges is, however, not regarded generally as suitable for steam pipes, as the rivets are liable to leak and the steam has the effect of cutting away the head (Fig. 4). A flange of steel screwed very hard on to the pipe, and with a properly-formed vanishing thread so as to weaken only by the smallest appreciable extent the strength of the pipe, and riveted slightly over on the outside face of the flange, forms a very good joint for a steam pipe, and the one which has been used probably most of all. In this case also a proper recess is made on one of the flanges, which holds the jointing material, and into which a part of the neighboring flange just enters. This joint, when properly made, is capable of bearing extreme pressure, and, like all other joints, it should be proportioned so as to be considerably stronger than the pipes (Fig. 5).

"The type of flange which is pre-

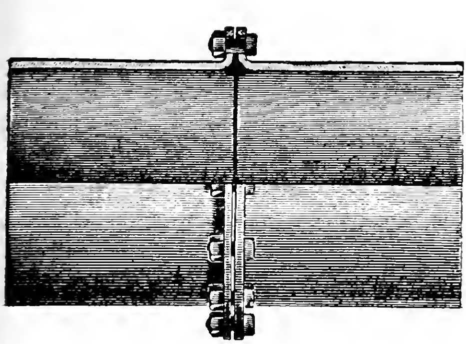


Fig. 1.

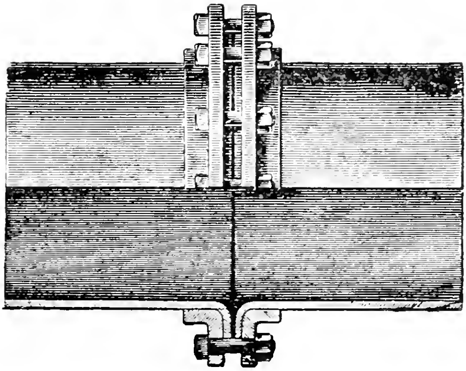


Fig. 2.

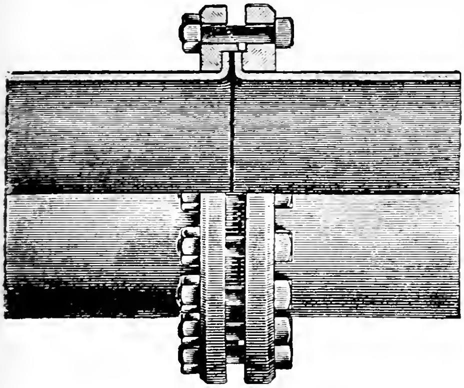


Fig. 3.

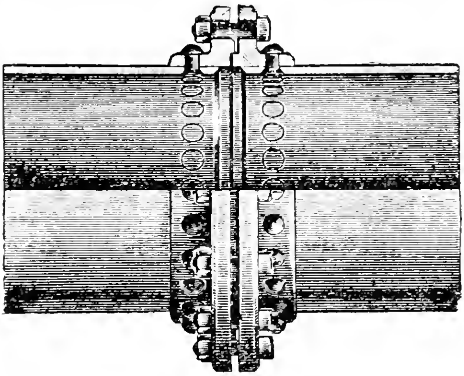


Fig. 4.

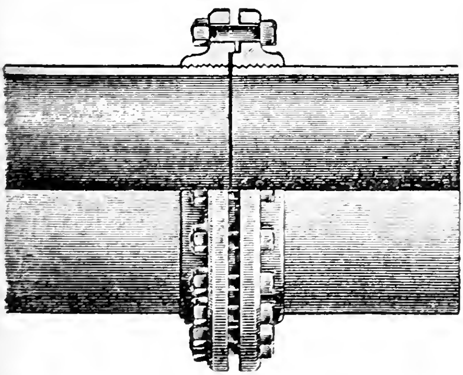


Fig. 5.

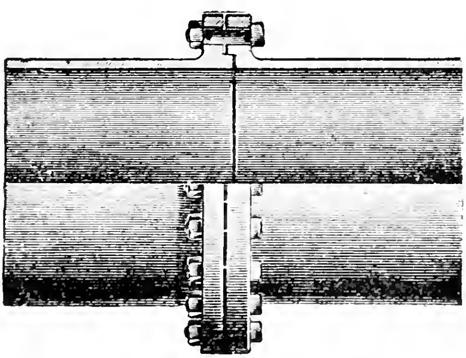


Fig. 6.

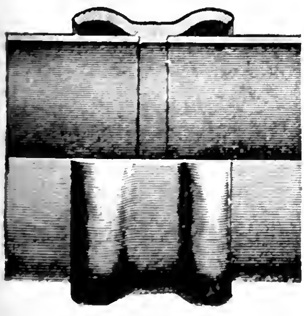


Fig. 7.

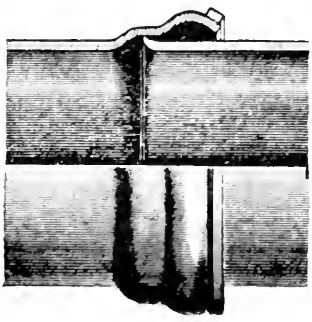


Fig. 8.

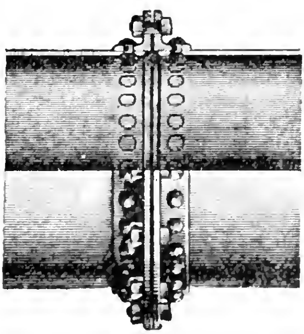


Fig. 9.

ferred for highest pressures and durability is a steel or iron flange welded on to the end of the pipe (Fig. 6), and this type of flange has practically no real advantage over that previously described under ordinary circumstances of pressure, but it has a certain popularity owing to its being solidly welded to the pipe. Various experiments have been made in attempting to pull the flange off the pipe by hydraulic pressure, but, as might have been expected, the pipes have burst before the flanges were moved. This, however, is also the case with regard to attempts to remove the screwed-on flange. For example:

"A 12in. × $\frac{7}{16}$in. tube, with flange screwed on, burst at a pressure of about 3 000 lbs. The pressure sustained by this flange was 144 tons, or 9,000 lbs. per inch of screwed surface.

"The solid welded-on flange has also been experimented upon to a considerable extent, and all efforts to pull this, the flange, from the pipe by internal pressure have failed.

"Another form of joint which, although used sometimes for temporary purposes, is more generally permanent, is the connecting together of pipes by screwed sockets. These have been made for sizes up to 30in. but the labor involved in putting together those large pipes by this kind of joint makes it difficult to see how it can be advantageously used as a removable joint. It is used very commonly for boring purposes.

"Amongst permanent joints, or such as are generally used as permanent joints, there is the collar joint for water mains, formed by a rolled and welded steel collar, enclosing a certain length of the ends of the two pipes to be joined, with a space between the collar and the pipe, which is filled with lead (Fig. 7). The patent inserted lead joint, formed by bulging one end of the pipe so as to hold the other, or spigot, end of the neighboring pipe, and providing that the inside of this annular space is larger than the mouth, thereby forming a lock-joint (which prevents the lead from being blown out), is an improvement upon this, as it consists of only one joint, while the first considered consists of two; and it is very generally used for water-pipes, as the joint can be formed very rapidly, and it provides a certain amount of elasticity, and allows for expansion and movement of the pipe, without almost any leakage; and the leakage, if it does occur, is very easily taken up. The amount of lead required is very small (Fig. 8).

"The only other form of jointing in use for a permanent purpose is that of riveting the pipes together, either by making them conical or telescopic. As this necessitates more work being done, and more time lost at the site where the pipes are laid (often in countries where labor for such a purpose can hardly be got), it seems, as a general rule, not to be so well suited as the two former joints described. Riveted-on steel flanges, with inside riveting flush so as to offer no resistance to water-flow, have also been used, but more commonly for vertical pipes, such as mining mains (Fig. 9 and Fig. 4)."

Requirements for Tensile Strength in Cement Specifications.

THE pulling tests for iron and steel have reached a considerable degree of refinement and accuracy, and necessarily so, for this material in practice is subjected principally to tensile stresses. But why such a degree of refinement should be attempted in cement requirements, when the principal stresses to which it is subject are compression, is more than we can imagine. And, when the refinements of these specifications are compared with the parallel tests of "experts," we are compelled to wonder what the test is worth. If the test itself is not analogous to the usual stresses encountered in practice (not including concrete arches), and there is no uniformity in the results obtained, it would be interesting to know just what the test does tell an engineer, especially where the cement is used in masonry mortar. Mr. J. M. Porter, while in charge of some construction work, discovered that the cement tests, where repeated by different persons, varied widely. He says in the *Engineering News* (Mar. 5): "To find what varying results different persons would obtain from the same sample of cement, the writer had ten samples taken from as many barrels of a certain brand of Portland cement. These samples were thoroughly mixed together and portioned into ten smaller samples of average quality, which were sent to ten different persons, with a request that a seven-day tensile test, one to three sand, be made according to their understanding of the method proposed by the committee of American Society of Civil Engineers. The accompanying table gives the results obtained from nine different persons, arranged according to their averages."

No. Laboratory.	Tensile Strength in lbs. of Briquette. No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	Aver.	Water, per cent.	Kind of Machine.
1. R. W. Hildreth & Co., New York....	68	72	74	78	82	..	75	12.0	Riehle, Driven by hand.
2. Washington University, St. Louis, Mo. Prof. J. B. Johnson....	77	94	108	110	122	..	102	Not known.	Fairbanks, Johnson's Clip.
3. City of Easton, Pa. H. R. Fehr, City Eng...	106	112	123	..	..	..	114	10.4	Fairbanks.
4. Columbia College, New York. Prof. W. H. Burr.......	125	126	130	137	140	144	133	10.0	Riehle, Driven by hand.
	126	132	138	144	150	153	140	8.0	
5. Chas. F. McKenna, New York....	14[illegible]	150	151	155	160	..	153	12.0	Riehle-McKenna Power driven, Rubber Clip.
6. Cornell University, Ithaca, N. Y. Prof. F. P Spalding....	155	160	164	166	172	..	163	Not given.	Lever with water bucket.
7. Lafayette College, Easton, Pa. J. M. Porter...........	171	177	177	178	179	..	176	11.0	Olsen-Porter, Porter Clip.
8. Clifford Richardson, Washington, D. C....	220	224	226	228	228	..	225	10.0	Riehle, Driven by hand, Rubber Clip.
9. Booth, Garrett & Blair, Philadelphia, Pa...	240	246	249	250	252	..	247	12 0	Olsen, Power driven, Rubber Clip.
Average................	..	..	..	..	..	..	153	10.8	66⅔% Power, 33⅓% Hand

in accordance with a given method, and yet the results vary widely, either the method is at fault, or the results have no value unless weighed by the varying personal equation of the manipulator.

"The writer had two men in his employ, both equally skilled in cement testing, make a tensile test on five briquettes, one to three sand, on the same sample of cement. The tests were made in the same laboratory, the mixing and molding being done at the same time, and the same bath was used, thus eliminating all atmospheric and water conditions. The results were to each other as 85 to 100; and, if the lower one had been taken, the cement would have fallen below requirements, while, taking the higher result, the cement would have passed. The question was, which result to adopt?

"What value has a tensile requirement in cement specifications under the present method of testing when one person obtains thirty pounds, and another one hundred pounds as a result upon the same sample? The cement which one engineer would accept would be rejected by another under the same specifications. Where do the contractor and cement manufacturer stand in this matter? The writer knows that cement can be made to stand almost any tensile requirement within reasonable limits that would ordinarily be made by varying the method of mixing and molding, but, when the mixing and molding are supposed to be done

"From the figures given in the table it is evident that the personal equation is a decidedly important factor in cement-testing, and, before tensile requirements in specifications can have any meaning, a method must be adopted that will considerably reduce or entirely eliminate this factor. With this in view, the following requirements are suggested:

"(1) Mixing and tempering by machinery, using enough mixture to make a given number of briquettes.

"(2) Molding under a given pressure.

"(3) Regulation in regar d to the bath, and manner of placing briquettes in the same.

"(4) Abolishing the use of all testing machines applying the load by hand."

The Painting of Iron Surfaces.

In a prize competition announced by the Society for the Promotion of Industrial Arts Prof. J. Spennrath submitted a contribution giving the results of his experiments in this direction, which have been translated by Mr. Henry Szlapka and published in the *American Gas Light Journal* (March 2). He says that some think that the combination of metallic oxids with linseed oil is a chemical one resembling saponification. He maintains on the contrary, that such is not the case and continues: "After having settled this much, it is a relatively simple matter to determine intelligently whether an oil paint will prove durable under given conditions. Since the destruction of the coat of paint is dependent upon a change in both of its constituents, which are not chemically united, we need only ask ourselves the question what the changes are which the acting materials and forces can produce, first in the pigment, and secondly on the vehicle. Combinations of zinc and lead are easily changeable under certain conditions, and, therefore, to be used with caution. Zinc-white and zinc-gray are changed by smoking hydrochloric acid into chlorid of zinc, after which the linseed oil is attacked. A coat of zinc-white is rapidly destroyed in the open air, because the zinc-white is changed through the action of carbonic acid and water into a crystalline carbonate of zinc, which swells to double the primitive volume; in a closed room such a coat lasts considerably longer, on account of the absence of water, although carbonic acid is present. A similar increase in volume (about thirty-three per cent.) is experienced by red lead, if, by absorption of sulphureted hydrogen, it is changed into sulphate of lead. White lead also is destroyed by the action of sulphureted hydrogen and acids. In spite of this, Prof. Spennrath considers red and white lead, if used in a pure atmosphere, as suitable pigments. Fault has been found with them in cases where the vehicle, and not the pigment, was the mischievous factor. Since red-lead paints are more used than any others, it is no more than natural that more bad places should be discovered in them than in others.

"Pigments which are stable to a high degree, if not absolutely so, are the following: carbon, especially as finely-ground graphite in which it is used in the so-called bessemer paints, as finely-ground charcoal, and as lampblack; heavy spar, which, however, possesses little covering capacity; artificial and natural iron oxids. To the latter class belongs the pigment of the lately introduced 'armor paint.' The professor declares the latter to be just as stable and as perishable as any other oil paint whose pigment can resist the chemical action of the atmosphere and other influences. He condemns the 'senseless' statements of manufacturers who ascribe to their pigments, of which every particle is embedded in a layer of resinous oil, and, therefore, entirely separated from the surface of the iron. an electrical action upon the latter.

"It may be remarked that the object of cooking the oil is to precipitate the slimy substances contained in it, and thus fit it for the better reception of the oxygen. Cooked oil becomes quite hard in one day, while uncooked oil requires two weeks to harden.

"Certain effects of the worst kind cannot be detected at all, as long as the paint adheres to the iron. Such considerations led to the use of paint films, which were obtained by giving a thin sheet of zinc three carefully-applied coats, allowing the paint to dry completely, and then dipping it into sulphuric acid, which rapidly dissolved the zinc, but left the paint film uninjured. Twenty different experiments with such films led to the following conclusions:

"1. Every paint is destroyed by diluted chloric and nitric acids; also by vapors of the same sulphuric and acetic acids. Acid vapors act more rapidly than diluted solutions of the same in water. Diluted sulphuric acid does not attack an oil paint.

"2. Alkaline fluids and gases, ammonia, sulphids of ammonia, and soda solutions destroy any paint rapidly.

"3. Pure water acts more strongly than solutions of common salt, sal-ammoniac or chlorid of magnesium, or natural sea water, which are feared so much as rust-producing bodies. The amount of salt in solution reduces the effect of water on the paint. The destructive action of sea water must be ascribed to the mechanical effect of the waves on the paint covering.

"4. Hot water acts more rapidly than water at ordinary temperature, and may even destroy oil paint in a short time.

"5. The constituents of coal ash soluble in water act destructively, in consequence of their alkaline nature. For this reason the fine ashes thrown up from chimneys and settling on painted iron surfaces are to be looked on as a danger."

Temperature is the worst enemy of paint. At 203° F. the paint films in the professor's experiments became brittle, and shortened several per cent. Graphite paints were less brittle than lead or zinc paints. Of course, this cracking allows moisture to come in contact with the iron, and the result is rust.

It is seen from these remarks that the conditions which affect adversely the durability of protective coatings are numerous. The common means for preventing rust may often be very inadequate, and it seems a very difficult matter to provide any one kind of protection that will withstand all kinds of deleterious influences. However, paint of good quality applied with proper care is probably the best resource for large structures.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

Bridges.

*5012. Accident to Rochester Bridge (This accident to a cast iron girder bridge is interesting in many details. The fine half-tone illustrations show the location and character of the fractures very plainly). Engng-March 20. 1200 w.

5132. Melan Concrete and Steel Arch Bridge, Topeka, Kansas (A five span concrete bridge, stiffened by longitudinal lattice arches, spaced 3 ft. apart. The method of construction is explained fully, and special attention is given to the examination of concrete. An inset plate illustrates the details). Eng News-April 2. 2800 w.

Canals, Rivers and Harbors.

4769. The Report on the Nicaragua Canal (An editorial review of some of the most significant points brought out in the recent report made by a Board of Engineers on the Nicaragua Canal project. This article is confined to showing how entirely insufficient the information now available is, to enable one to form a judgment of the cost and practicability of the scheme). R R Gaz-March 13. 3500 w.

4882. The Report on the Nicaragua Canal (An editorial review of a portion of the report of the United States Board of Engineers on the Nicaragua Canal, going to show the insufficiency of information heretofore collected). R R Gaz-March 20. 1900 w.

4886. English and American Dredging Practice. A. W. Robinson (A letter to the editor discussing the advantages and disadvantages of various forms of dredgers). Eng News-March 19. 1900 w.

*4926. Proposed Ship Canal for Connecting the Bristol and English Channels. W. O. E. Meade-King (A full description of the scheme). Eng, Lond-March 13. Serial. 1st part. 1800 w.

4984. The Report of the Nicaragua Canal Board (The full text of the report is given with a map of the route. It includes the general characteristics of the country, a history of former projects and a full discussion of the present scheme. Also editorial). Eng News-March 26. 36000 w.

4987. The St. Lawrence Water Route to the Sea. Thomas Monro (Address of the retiring president of the Canadian society of civil engineers, in which he expresses some of the reasons why the St. Lawrence River is not more used by commerce). Eng News-March 26. 1300 w.

4989. River Regulation by Suspended Fascines in Bavaria (The devices used by European engineers in directing the courses of rivers are well described, and illustrated by eleven drawings). Eng News-March 26. 1500 w.

*5241. The Problem of Bristol Docks. (The necessary improvements were first reported on by the resident Docks Engineer, and then Mr. Barry, whose estimates are here discussed, was asked to report on the same scheme. The cost of this work is estimated at £2,580,000). Eng, Lond-March 27. 2500 w.

5246. Methods of Work and Special Plant on the Chicago Drainage Canal. (The first of series of articles giving a comprehensive résumé of the design and work on this important project. It is well illustrated by maps and profiles). Eng Rec–April 4. Serial. 1st part. 3800 w.

Hydraulics.

4867. Queen Lane Reservoir, Philadelphia (The article upon this interesting problem is very well illustrated by sections, details, maps and plans. The best methods to prevent leaking are discussed). Eng Rec–March 14. 2200 w.

4967. "Water Renaissance." John Birkinbine (A paper read before the Engineers' Club of Philadelphia upon the revival of water power as an engineering specialty). Ir Age–March 26. 1800 w.

4985. The New Water Power Development Below Niagara Falls (The head of water utilized is about 125 ft. Five illustrations showing the location, arrangement, and general appearance of the paper-mill plant are given). Eng News–March 26. 800 w.

5036. Erection of a Long Plate-Girder Railroad Bridge (The requirements of this specification cover all necessary considerations). Eng Rec–March 28. 400 w.

Irrigation.

*4735. Pump Irrigation on the Great Plains. Ill. H. V. Hinckley (Showing that pump irrigation contributes to the preservation of small farming and increases the value of land, and giving directions regarding selection of plant and power). Eng Mag–April. 3400 w.

5245. Some Late Features of the Hydraulics of Irrigation. (From Bul. No. 33, of the Colorado Agricultural Experiment Station, showing that in the Poudre River district, one-third the irrigating water returned to that river, and about 30% on the Platte). Eng Rec–April 4. 900 w.

Miscellany.

4755. Specifications for Asphalt Reservoir Linings at Philadelphia (These specifications on asphalt reservoir linings are said to be the first in the East. Three methods are specified but bids will be received from contractor's designs also). Eng News–March 12. 1400 w.

*4855. Triangulation Preparatory to Alignment of a Tunnel. William W. Redfield (The article is accompanied by a diagram and profile with full description of method employed in connecting two shafts at Minneapolis by a tunnel for the water supply). Jour Assn of Eng Soc–Feb. 1000 w.

4864. The Remuneration of Engineers (Editorial comment upon the smallness of engineers' salaries, as compared with that of specialists in other professions, and the resultant effect on both engineers and their work). Eng Rec–March 14. 600 w.

4883. Tests of Strength of Vitrified Clay (These tests are valuable for reference in designing structures where terra-cotta ware is to be used). Eng News–March 19 600 w.

4884. A New Formula for the Curvature of Chords in Truss Bridges. Benjamin F. La Rue (The formula is deduced and it is believed to be of practical value in facilitating calculations). Eng News–March 19. 1500 w.

4885. The Cyclotomic Transit. Otto von Geldern (A paper read before the Technical Society of the Pacific Coast, on a transit with a fixed lower plate and a floating exterior ring, thus not interfering with the rigidity of the central spindle. The arrangement is illustrated in section and plan). Eng News–March 19. 2400 w.

4887. Race Track of the National Cycle & Athletic Club at Manhattan Beach, L. I. (A full description, including a general view, plan and sections. The track is a model bicycle racing track designed for high speed). Eng News–March 19. 2000 w.

*4910. Vibrations and Engineering. John Milne (Earthquake vibrations, train and engine vibrations, etc., are discussed from a scientific standpoint and illustrated by view and diagram). Engng–March 13. Serial. 1st part. 2700 w.

*4925. The Elements of Success in Engineering as a Profession (The editor states that success is due more to the character of a man than to his genius. The article is quite interesting). Eng, Lond–March 13. 1600 w.

4931. Economical Designing of Timber Trestles. A. L. Johnson (Abstract from Bul. No. 12 of the U. S. Division of Forestry, giving also Mr. Lindenthal's comments thereon. The various designs are illustrated and dimensions and formulæ given for making calculations). Ry Rev–March 21. 2700 w.

4966. A Great Coal Dock on Lake Superior (The dock is situated at Duluth, Minn., has a storage capacity of 250,000 tons, is 1560 ft. long and 300 ft. wide, has covered bins 950×150 ft. in area, and loading and unloading is done entirely by mechanical conveyors and buckets). Sci Am–March 28. 400 w.

4982. Trolley Cars and Surveying Instruments (A caution to engineers not to put their instruments near the motors when riding on the cars). Eng News–March 26. 600 w.

4993 —$1.50. The Transverse Strength of Beams as a Direct Function of the Tensile and Crushing Stresses of Material. M. Lewinson (The author contends that the neutral axis does not pass through the center of gravity of the cross section of a beam). Trans Am Soc of Civ Eng–March. 2500 w.

4994.—$1.50. Concerning Foundations for Heavy Buildings in New York City. Charles Sooysmith (General considerations which show the danger of overloading the ground on which large buildings are placed). Trans Am Soc of Civ Eng–March. 4400 w.

5050. Notes on Overloaded White Pine. Justin Burns (Showing that a higher allowable unit stress could be used in designing). Ry Rev–March 28. 500 w.

5064. A Florida Kaolin Mine (This interesting description is from the *Jacksonville (Fla.) Citizen*. The process for preparing porcelain clays for market is described in popular style). Clay Rec–March 28. 1800 w.

5149. A Method of Determining the Size of a Beam or Girder from Irregular Loading. Robert D. Kinney (A theoretical discussion with derivation of formula and solution of a problem). Power–April. 1200 w.

Air-Pump and Ejector in Steam Heating.

MR. G. W. SCOTT, in *The Iron Trade Review* (March 12), gives data for a comparison of results in the use respectively of these two devices, premising that the function of the air-pump is to produce and maintain a partial vacuum in the returns of the heating coils and radiators, and, aided by a thermostatic valve, "to afford an easy and natural exit for the entrained air and water, while the ejector acts only to remove the air, the water flowing back by gravity.

"Let us suppose that the volume within the return pipes is equal to two cubic feet; and let us first deal with the air-pump, which, we may suppose, has an area of 36 square inches, and a stroke of 12 inches, giving a volume of one-half of a cubic foot for each double stroke. Now, if we assume that at the commencement of the operation the air in the returns is at the ordinary atmospheric pressure of 14.7 lbs. per square inch, then it can be demonstrated that at the end of the fifteenth double stroke the pressure within the pipes will have decreased to 5.1744 lbs., per square inch. And, since the area of the pump is 36 inches, then the work done in the air-pump will be represented by $36 \times 4.7628 \times 2 \times 15 = 5{,}143{,}824$, foot pounds,—the 4.7628 being pounds per square inch of average vacuum load.

"Turning now to the ejector, we may consider what is done in this case in the work of reducing two cubic feet of air at an initial pressure of 14.7 lbs. per square inch, to a final pressure, as in the case of the air-pump, of 5.1744 lbs. per square inch. Clearly the work done is due to the velocity of the steam and part of this motion being taken up by the air with which the steam comes in contact. And, if we assume the steam to be of a total pressure of 75 lbs. per square inch, its highest possible velocity due to such pressure and its weight will be about 1,700 feet per second, the corresponding velocity of air at the pressure of one atmosphere being about 1,300 feet per second."

"Furthermore, it is generally conceded that the efficiency of a jet is at the highest when allowed the maximum velocity. And we shall, therefore, suppose the initial velocity of the combined steam and air to be 1,300 feet per second,—a velocity acquired from a certain weight of steam at 1,700 feet per second. Taking the weight of a cubic foot of air at normal pressure to be 0.08 lbs., then the weight of two cubic feet will be 0.16 lbs., and, therefore, the corresponding weight of two cubic feet of air at 5.1744 lbs. per square inch will be 0.05632 lbs. In other words, to obtain this final pressure of 5.1744 lbs. per square inch, it is necessary to remove 0.10368 lbs. of air from the original quantity. Now, it is immaterial whether we remove this air particle by particle, or as a whole; the theoretical consideration is the same within close limits. But for convenience we shall consider it drawn out as a whole. And the weight of steam required for this purpose will be found by the following equation, where x=the weight required.

$$x \times 1700 = x \times 1300 + 0.10368 \times 1300,$$

which gives 0.33696 for the value of x and the weight of steam required.

"Now, the initial energy of this moving body of steam is found by the well-known expression, $\frac{W \; V^2}{Z \; G}$ which gives, in this case, 15,121.34 foot-pounds. And, recalling the conclusion that only 5,143.824 foot-pounds were required for the air-pump, and comparing these theoretical values, it may readily be seen that the ejector requires $15{,}121.34 \div 5{,}143.824 = 293$ times the quantity of steam required for the air pump."

It should not be overlooked that these values are quite apart from radiation, friction, and internal losses generally. But, while the air-pump has its friction load to be added to the useful load, and to this extent would require additional steam, it must not be lost sight of that the friction of the steam and air in the ejector and pipes is considerable in its relative magnitude. And it should be further noted that, while the ejector discharges the air into the atmosphere, which is perfectly proper, it also discharges the accompanying steam, laden with latent heat, in the same direction, which is highly improper, although in the nature of the case unavoidable.

Accuracy of Gas Meters.

One of the most prevalent notions among consumers of gas is that gas meters are, as a rule, inaccurate. It is curious to hear some of the remarks made upon this subject by people who think they have not used as much gas as they are charged with in the periodical presentation of bills, and it is difficult to believe that people truthful in ordinary affairs of life intentionally falsify in their condemnation of the fancied unreliability of gas-meter indications.

In a discussion of this matter at a recent meeting of the Ohio Gas Light Association, reported in the *American Gas Light Journal* (April 6), one of the members made a statement the following abstract of which contains the entire truth upon the gas-meter question.

"We had consumers in whom we had implicit confidence, who would tell us there must be something wrong,—that they surely had not consumed the amount of gas that the bill indicated. In such instances it was our rule to take the meter out and invite the consumer to come down and prove it. We explained to him the workings of the meter, which are very simple. And, by the way, I would say that a meter is just as accurate as a watch; no watch was ever made that would keep accurate time for twelve consecutive months; neither is there a meter that would perform accurate work for that length of time; but the meter for its purpose is just as accurate as the watch. After we had explained the workings of the meter to this consumer, we would show him the prover. As you are all aware, a child of ten years can understand the prover. As a matter of course, the meter had stood long enough in the room to become of the same temperature as the air of the room, and, after he had seen for himself the workings of the prover and the meter, he would be perfectly satisfied."

Another member described a method whereby his company is able very often to trace discrepancies between the amounts of gas registered by meters and the rental estimates of those who protest against supposed excess in the indications. He said:

"We have always had our register clerks make a notation of all reports on the bills that were inconsistent, and those were given special attention. Where we are not able to account for the variation, we either read the meter or make inquiries, or in some way attempt to satisfy ourselves, and, if possible, the consumer that is interested in the particular case. In this way we have been able to satisfy the consumer, so that even he was willing to pay a bill that did not seem reasonable. We found that in our meter books it is very easy for the meter reader to extend the consumption. It just makes an extension of one side of one or two figures, and they are instructed, where there is any discrepancy that cannot reasonably be accounted for, to make inquiry of the consumer as to the cause. We find this does away with the necessity of carefully examining the bills in the office, and it is done right at the time our attention is called to it, and, if there is anything to be explained, it can be explained at the time."

In the course of the discussion it was also brought out that ninety-five per cent. of inaccurate meters register against the company instead of against the consumer. A member said:

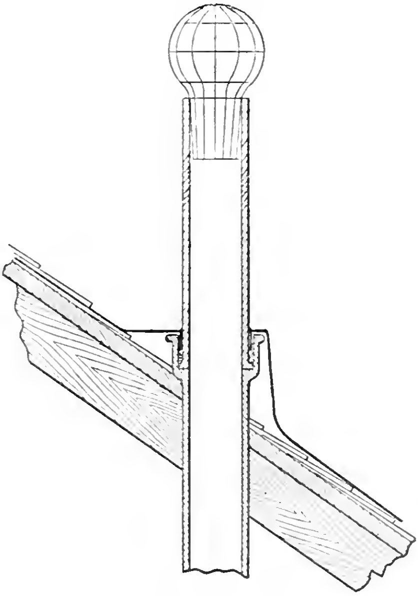
"Where there is a decided and notable increase in the amount of the bill, the gas company (I am speaking of the moderate-sized gas company, where they are not over-crowded) cannot afford to let that thing go by. If this bill jumps from $5 up to $15 or $20, I do not think I can put in a month's solid time for my company which will earn them any more money than to find out what is the matter. I believe most people who raise a racket about an undue and unreasonable increase in their gas bills are honest; I think they are conscientious, when they say they do not understand them. An instance comes to my mind now, where a month's time was spent in solving such a case as that, and I do not believe the company could have the spent same amount of money or time in any other way that would have done as much good. Of course, every community has some members who want to give the gas company a bad name; but there are many more who want to do what is right and fair. A great many people twit us when they come around to pay their bills, but the great bulk of it is mere pleasantry, and not in earnest; but, if a person really thinks he is paying for more gas than he got, the company cannot afford to let it go. I believe, in ninety-nine cases out of one hundred, by taking the necessary time and paying attention to the matter, the cause can be found, and, when it is found, the company is amply repaid for the inconvenience to which it has been put."

While there may be occasional failure in accuracy of meters, the fact remains that, as a rule, gas is measured as accurately by meters as is nearly any other article of domestic consumption by the scales and measures in common use. In most cases where gas bills seem exorbitant, this arises either from forgetfulness of occasions wherein the actual use was greater than usual, or in the surreptitious use of gas by servants in dwellings or clerks in offices. In one instance it was found the clerks in an office had organized a poker club, and were in the habit of burning gas nightly long after business hours.

A Soil-Pipe Roof Connection.

A CORRESPONDENT of *The Metal Worker* (April 4) describes the herewith illustrated method of making a tight connection for soil pipe in a shingled roof, which appears to be so satisfactory that we reprint the description for the benefit of our readers. It seems that with very little modification the method might be extended also to slate roofs.

"With the plumbing regulations of many cities requiring that the vent stack from a plumbing system shall extend through the roof, the problem of making the roof water-tight at the place of exit is presented. Where the roof is flat or of sheet metal, it is a comparatively easy matter. The illustration herewith shows the method of making the roof connection tight, when it is through a shingle roof having a sharp slant. The soil-pipe stack should be cut off so that the hob extends to a short distance—1½ inches—above the roof at the top edge. A piece of sheet lead is best adapted for making a tight connection. A hole should be cut in the lead about 1 inch smaller than the



diameter of the soil pipe that is to be used. It should then be notched with a pair of shears, so that it may be turned down inside of the hub, and should be dressed down around the hub, so that it will lie flat on the roof; and, when used on a shingle roof, it should extend far enough under the shingles so that the manner of breaking the joints on the shingles will prevent water from passing under it. The piece of lead should be sufficiently large to extend on each side some distance away from the pipe, and also at the bottom. From the nature of lead, it can be very readily dressed or beaten up to whatever shape is necessary to cause it to lie flat on the roof and to extend up to the cast-iron hub. After this part of the work has been done on a continuation of the soil pipe, the stack can be made by inserting a piece of pipe into the hub end, as shown. The joint should be calked with oakum, and then melted lead poured in the hub until it is flush with the top. By this means a perfectly water-tight joint can be made. The illustration shows a wire ball used on the top of the vent stack to prevent the entrance of birds, leaves, and other matter. This style of vent protection, as used by some, is open to objection. It is quite possible for it to be effectually stopped in a snow storm. A better method is to use some sort of a top or cap, which prevents water from entering the vent stack, and which presents a sufficient space for the entrance and exit of air, but not enough for the entrance of birds. With a cap which extends sufficiently over the pipe, there is little danger of the vent becoming entirely clogged with snow or sleet."

Disposal of Waste in Country Places.

DR. HARVEY B. BAYSMORE, in *The Sanitarian* for March, writes of the meager attention paid to this important subject by dwellers in country places. The privies in common use should either be abolished, or be placed far from any well, and their vaults should be made water-tight cisterns. They should be frequently emptied. Far better, from every point of view, is the dry-earth closet, or better still the dry-ash closet, since sifted coal ashes make the very best kind of absorbent, "a quart or so being sufficient at each time of use."

"In this manner we have, too, a method of utilizing the ashes. The closet-pail should be emptied at least once a week, and placed in the sun for several hours. The refuse should be kept in some dry place, and carted away from time to time for use as a fertilizer. Ash-closets, when given a little care, are an odorless, cleanly, and safe method of disposal. Urine wash and kitchen waters are best gotten rid of by some system of irrigation, either subsoil or surface,—preferably by surface irrigation, as being less trouble, less expensive, and perhaps the most efficient method. A small vegetable bed, about twenty by twenty-four feet, for a family of three or four, is all that is required. The slop-receiver can be placed at the corner of the bed, or at an out-of-the-way corner of the house, fitted with pipes and leading to the bed, which should be laid out in furrows. In the summer the furrows can be arranged between the rows of vegetables, so as not in the least to interfere with cleanly cultivation. In the winter the water must be poured into the receptacle only at intervals, and then in sufficient quantity to completely flush the pipes; otherwise freezing would follow, and greatly interfere with the workings of the system. This area, though small, will effectually dispose of an amount of waste water very surprising, and without any odor arising therefrom. The only work required is occasional raking and renewing the furrows. In surface-irrigation sunlight and oxygen are the great prejudicial factors to the growth of pathogenic and saprophytic bacteria, and the organisms of Schlossing, Muntz, and Warrington soon change the filth into ammonia and nitrates. There is no danger of well infection by disposal of liquid in this manner, unless the land slopes directly to the well, for the filth is effectually disposed of in the surface soil."

Sub-soil irrigation is also recommended as a good method for the disposal of all liquid wastes. "The receptacle can be placed at any convenient place, as for surface-irrigation. The arrangement of the bed is very simple. Lay agricultural drain tiles about ten inches below the surface, radiating from the point of departure under the bed in fan form, the end pipes all coming to the surface so as to allow the free circulation of air. A flush tank, of course, can be used, but this unnecessarily complicates the plant."

Where water-closets are used, as in the houses of most wealthy people, the method now to be described is the best substitute for sewers. "Instead of a cesspool, a small, shallow tank should be built in a convenient location, several hundred feet from the house, at the edge of some cultivated field. The house sewer should have pipe connected with this tank. An automatic flush tank with pipe-connection suitably arranged distributes the sewage over the land appropriated to the purpose. For the small amount of sewage furnished by one family no special preparation of the soil is necessary, save that it has suitable fall and drainage." The author recommends the cultivation of corn on such a field, in preference to grain or vegetables, for in a corn-field the soil is more exposed to sunlight than in the thickly-covered grain-field.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Domestic Engineering in the American, English and British Colonial Magazines Journals—See Introductory.

Heating and Ventilation.

4797. Air Pump and Ejector in Steam-Heating. G. W. Scott (Relative efficiency and economy of these devices). Ir Tr Rev–March 12. 1300 w.

4891. Novel Residence Hot Water Heating Plant (Illustrated detailed description of a plant quite out of the common run, designed especially to meet unusual requirements). Heat & Ven–March 15. 1400 w.

4892. The Drop System of Steam Heating. Thomas Barwick (Advantages of the system for many buildings are urged and examples of its application cited). Heat & Ven–March 15. 2000 w.

4893. Fan-Furnace System of Heating and Ventilation. George W. Kramer (Essentials to good results in this system are definitely stated and the article is of general practical value). Heat & Ven–March 15. 2000 w.

4897. Heating of the Armour Buildings at Chicago, Ill. (Illustrated description of central installment for heating twenty-nine buildings, comprising the Armour flats and Armour Mission, Chicago, Ill). Eng Rec–March 21. 1200 w.

5040. Indirect Hot-Water Heating in a Rochester Residence (Illustrated description). Eng Rec–March 28. 500 w.

5249. Heating and Ventilating of a U. S. Custom-House. (Illustrated detailed description. Low pressure exhaust steam is used, and a combination of direct, direct-indirect and indirect radiators is employed, the indirect radiators being supplied with air by fans, etc.) Eng Rec–April 4. 1000 w.

Landscape Gardening.

4875. The Importance of Water in Plant Production. Thomas F. Hunt (A scientific dissertation, useful not only to agriculturists, and horticulturists, but to students of the art of irrigation). Clay Rec–March 14. 5200 w.

4963. John Bartram's Garden To-Day. Ill. M. L. Dock, with editorial (Facts relating to the preservation of John Bartram's garden. Description and historical account). Gar & For–March 25. 3000 w.

5109. What Would Be Fair Must First Be Fit. Charles Eliot (The application of the truth stated in the subject to landscape gardening, with some reference to, and criticism of the professional workers in this field). Gar & For–April 1. 1400 w.

5204. Dangerous Enemies of Trees (Editorial on the beauty and care of trees bordering streets, the necessity of awakening public sentiment for their protection, etc.). Gar & For–April 8. 1500 w.

5205. Proposed Plan for Madison Square, New York City. M. G. Van Rensselaer (The plan of Madison Square as it is, and the plan for its rearrangement as suggested by Messrs. Bell & Langton, landscape architects, is given and discussed). Gar & For–April 8. 1400 w.

Plumbing and Gas Fitting.

*4839. Kitchen Plumbing (Illustrated description of high class work). Dom Engng–March. 500 w.

4872. Plumbing in the American Surety Building (Describes and illustrates in detail the plumbing installment in a building twenty-one stories in height, or 311 feet above the sidewalk). Eng Rec–March 14. Serial. 1st part. 1400 w.

Miscellany.

†4772. The Disposal of Waste in Country Places. Harvey B. Bayshore (Means and methods for the sanitary disposal of wastes and refuse from country homes). San–March. 1200 w.

*5023. Water Analysis (A series of articles designed to explain means and methods whereby the non-medical sanitary officer, or the busy medical officer of health, may make such examinations of water for domestic uses, as will enable him to announce authoritatively, its fitness or unfitness for such uses, without the delay usually necessary when submitting samples to experts for examination and analyses. The first part gives a list of apparatus needed, a table of weights and measures necessary for expressing results, a method of calculation involving only simple decimal arithmetic, and rules for conversion of results). San Rec–March 20. Serial. 1st part. 1400 w.

5041. Report of Sanitary Condition of Boston Schools (Report to the Mayor of Boston, made by a special committee of experts). Eng Rec–March 28. 1600 w.

*5104. The Combustion of Coal and Gas in House Fires. J. B. Cohen and G. H. Russell (Describes experiments instituted to determine how far coal combustion in residences and public buildings,—apart from the use of coal in industrial establishments,—contributes to the smoke nuisance, and how far this nuisance may be mitigated by the domestic use of gaseous fuel). Jour Gas Lgt–March 24. 2600 w.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading, and Domestic Engineering.

Electric Arc Experiments.

SOME curious experiments made by Mr. A. J. Wurts are described by him in *The Electrical Engineer* (March 18). We make the following abstract of this article:

"While experimenting some time ago with static discharges, I had occasion to pass a small discharge across a 1/32-inch gap, between electrodes which were placed in a heavy glass tube filled with oil and securely corked at either end. Much to my surprise, at the time when the discharge occurred, the glass tube was broken into small fragments; it did not burst as by an explosion; the tube simply fell to pieces. The experiment was repeated a number of times with the same result."

The phenomenon described by Mr. Wurts is accounted for by the displacement of a portion of the oil in the formation of the arc. The effect would thus be the same as though an amount of oil equal to that so displaced were forced into the tube. Reasoning further, he says "that, if the vessel had been relatively stronger than the electromotive force, the arc could not have formed; in other words, it seemed as though the elements were at hand for the construction of a switch capable of opening an electric circuit without an arc.

"Following out these ideas, I constructed an ordinary electric switch of about 100 amperes' capacity, which was suitably located in a sealed cast-iron vessel filled with oil. On placing this switch in a 500-volt direct-current circuit, I opened and closed the switch some eight or ten times on 30 amperes, and, upon removing the stopper from the cast-iron vessel, was surprised to see the oil spurt. On examining the oil, I found it had been considerably carbonized. The accumulation of pressure and the carbonization of the oil indicated the formation of an arc at the switch terminals, which for a time puzzled me considerably, as the formation of the arc had not entered into my calculations. On repeating the experiment, I neglected to replace the stopper, with the result that, when the switch was opened, a column of oil about six feet high was forced into the air. Testing again, with the vessel closed, I detected a slight gurgling sound when the switch was opened.

"Being still puzzled, I determined to see what was going on within the vessel, and had a heavy glass front constructed. Repeating the experiments, I noticed that, on opening the circuit, an arc was formed about the size of a pea. The same arc in air would have been about three inches long. After about a dozen breaks, however, the glass front was shattered, as though struck by a hammer. On further considering these results, it seemed to me that either the vessel had not been entirely filled with the oil, or that the vessel was sufficiently elastic to allow the formation of the small arc noticed. It is not unlikely that both of these conjectures were true. However, the arc which actually formed was so insignificant that I felt encouraged, and proceeded with my experiments, hoping to eventually produce results of practical value.

"My first step was to overcome the pressure which accumulated, due to the formation of gas by the arc in the oil. I placed in connection with the containing vessel a small reservoir, having a direct pin-hole communication with the main vessel; also a valve connection allowing oil to pass from the reservoir into the main vessel by gravity. The pinhole communication was placed in a dome directly over the switch terminals, so that the gases which formed would rise to the top of the dome and pass out into the reservoir, which latter was only partially filled with oil. The pressure being thereby released in the switch chamber, sufficient oil would flow through the valve communication from the reservoir to occupy the space which had been previously occupied by the gas. This plan proving satisfactory, I proceeded to determine the life of the switch as compared with a similar switch used for the same purpose in the open air. After making about three thousand breaks, I found that the oil had carbonized to such an extent that, with the switch open, there was a current leakage of several amperes. Various oils were subsequently tried, some of which proved better than others. Of these paraffine oil gave the best results.

"I next tried glycerine, and with it made forty thousand breaks. At the end of this test the switch terminals were found to be slightly scarred, the glycerine was black from carbonization, but the current leakage was only a small fraction of an ampere on open circuit.

"Having arrived at this point, I began to experience difficulty with the containing vessel, which now leaked badly, in spite of the best fittings I could procure. To overcome this difficulty, I determined to increase the density of the liquid. It seemed to me that not only would a more dense liquid be less easily forced through the joints, which necessarily enter into the construction of the apparatus, but that it would also more effectually resist the formation of the arc. Satisfactory tests were made with a mixture of precipitated silica and glycerine.

"Aside from the above results, the question 'Can an electric circuit be opened without an arc?' is exceedingly interesting from theoretical as well as practical standpoints. In connection with the electrical engineering problems of the day, it is one of no small importance."

Unsatisfactory Condition of the Incandescent Lamp.

NOT only in Europe, but also in the United States, is this subject attracting much attention. Unscrupulous competition has led to a deterioration of quality which has already injured the electric lighting business, and which, if it be allowed to go on, will result in a serious setback. The electric light has now to compete with the Welsbach burner, and there is also the possibility that it may find a strong rival in acetylene. If those engaged in the business compete recklessly with each other in addition, regardless of the quality of the light supplied, a period of great tribulation for this industry is certain. The following abstract of an article "on the commercial aspect of the incandescent lamp," by George R. Metcalfe (*Electricity*,) exposes the present situation.

"The present relations between the older lamp companies undoubtedly originated in the constant litigation carried on during the life of the fundamental Edison lamp patent. The field of lamp manufacture was opened in November, 1894, by the expiration of the Edison patent, and the successors of the Edison Company entered it with the avowed object of crushing its competitors by underselling them without regard to cost. Within a year the price of lamps was cut to nearly fifty per cent., and in some recent cases to about forty per cent., of the average price in 1894. A few of the weakest companies have succumbed in the struggle during the last year, but, although the trade generally has been demoralized, the effect of cutting prices has reacted quite as severely against the promoters of this policy as against its opponents. This business, however, can never become thoroughly settled as long as this style of competition exists; and, as any chance of monopolizing the business by any one concern has long been an apparent impossibility, the futility of this policy, as well as the financial loss it involves upon the whole trade, has become more than sufficient to show the desirability of its abandonment among the various lamp manufacturers."

Mr. Metcalfe easily demonstrates that this reduction in price has resulted in loss to the consumers, as well as to the manufacturers, on the principle that, if a purchaser gets for fifty per cent. of its former price an article worth only thirty per cent. of its former value, he loses forty per cent. in the transaction. That this is substantially the kind of effect produced by the cutting of prices in incandescent lamps is made very plain by a proper system of tests, and ample data for proving it are given in Mr. Metcalfe's article; and he alleges that this has been rendered possible by "a general absence of testing facilities, even in large plants. This renders deception an easy matter, and such advantage has been taken of it that the average consumer is now paying considerably more for a given amount of light than he had to pay before the prices of lamps were reduced.

"The makers, ratings of lamps frequently appear to be the result of very poor guesswork, and should never be accepted as accurate, either as to candle-power or efficiency, unless confirmed by the consumer's test. A lot of fifty lamps labelled 16 c. p., and represented to have an efficiency of 3.5 watts, were recently tested by the writer, out of which only six lamps were found correctly rated. They showed a very uniform consumption of 56 watts, but a photometer test showed that forty of them measured 14 c. p. or less, making their efficiency 4 watts and under. This over-rating is encouraged by the general demand for high-efficiency lamps of long life,—conditions that cannot be attained to any considerable extent outside of advertising literature. It can be readily seen that increasing the efficiency necessarily shortens the life of a lamp, and, conversely, lengthening the life reduces the efficiency. The efficiency of a lamp is increased by burning the filament at a higher temperature than is used with low-efficiency lamps, and the effect of this increased temperature on the filament is obviously to destroy it more rapidly in proportion as it burns hotter."

The proportion of first cost of lamps to that of the total cost of electric lighting is so small that efficiency, not low price, should be the controlling consideration in their purchase. "The life of a lamp may be increased at the expense of its efficiency by burning it at a lower heat,—and this is a costly way for the consumer,—or the increase may be by the reason of the filament being made denser and more homogeneous in structure. The latter qualities are, of course, desirable, as they add to the life as well as the efficiency of the lamp."

This proposition is also verified by figures which prove that a long life in an incandescent lamp is not necessarily economical or desirable, and that, after a certain limit has been reached, it is cheaper to purchase new lamps than to continue using the old ones.

"There are means of cheapening the cost of lamps which may save the manufacturer two or three cents, but which cost the consumer two or three dollars. In treating the filaments, the greatest care is necessary to secure uniformity in their resistance and efficiency, and, if sufficient time and attention is not given to this part of the work, the lamps will differ widely in their ratings. The exhaustion of air from the bulb is the most expensive operation in the manufacture of a lamp, and requires considerable time to effect, The most of this time is spent in removing the last traces of air and the occluded gases in the filament, and the cost of the lamp is considerably reduced by stopping this process prematurely. But, if the vacuum is not as perfect as it can be made, the effect is to reduce the efficiency of the lamp and to shorten its life. The reduction of the price of lamps is necessarily followed by a reduction in the amount of labor employed in their production, for which, in the end, the consumers pay a heavy price. If these considerations were taken into account, and better understood among consumers, competition would be directed entirely along the line of quality, and the eventual cost to users would decide the matter of economy without reference to the selling price of lamps."

Magnetic Tester for Sheet Iron.

THIS apparatus (described in *Scientific American Supplement*,) readily measures hysteresis directly and in a single operation, the test being applied to many specimens with little expenditure of time, trouble, or iron. We present herewith an abstract of the description. The instrument is based upon a process of reversa similar to that which takes place in a transformer, and is intended to be a practical tester for workshop use. The induction is caused to have practically the same value in all samples.

The samples to be tested are cut in a simple form, and are arranged to be readily inserted and removed. The reversal of the magnetism is effected by turning a handle, and the result is indicated by the position of a pointer on a scale. The iron samples are cut or stamped in the form of strips 3 in. long and 5/3 in. wide. The sample is composed of six or seven of these strips for the usual gages of transformer iron, while a smaller number is used, if the material tested is the thicker sheet used in dynamo armatures.

The magnetic tester consists of a permanent magnet arranged vertically and swinging about a knife edge working in an agate trough, a lifting arrangement being provided, like that of a balance, so as to save the knife edge from unnecessary wear and tear. The pointer, which is carried by the upper part of the magnet, is set to zero in the middle of the scale by means of a nut which runs on a screw projecting sidewise from the middle of the magnet, and a more delicate adjustment of the zero may be effected by means of a levelling screw. The bundle of iron strips constituting the sample to be tested is placed in a carrier, and is covered with a vulcanite washer and secured by two clamps. The carrier is made to rotate by means of a friction pulley and hand-driven wheel. This causes the sample to revolve between the poles of the magnet, with the effect that its magnetism is periodically reversed. The work done in reversing the magnetism in consequence of hysteresis causes a mechanical moment to be exerted by the revolving sample upon the magnet, and the latter, owing to its support by the knife edge previously mentioned, and which is in line with the axis of the carrier, tends to follow the sample, and is deflected through a handle which serves to measure the work expended. Since a definite amount of work is done per reversal, the deflection of the field magnet is independent of the speed at which the carrier revolves, and no special care has to be taken to turn the handle of the driving wheel at a uniform rate. The swinging of the magnet is checked by a dash pot below, and the stability is adjusted to give any required degree of sensitiveness. The operation of testing is effected by the insertion of the sample, and, after reading the deflection of the pointer toward one side, the observer reverses the direction of rotation, reads the deflection toward the other side, and takes the sum of the two readings as the total deflection. The deflection is proportional, or approximately so, to the hysteresis of the iron, even when a comparison is made of samples widely different in quality. To insure that this shall be so, a considerable air space is left between the magnet poles and the ends of the sample, with the result that such variations of permeability as are liable to be met with in different samples of iron are almost without influence upon the total induction through the iron. The dimensions and strength of the field magnet are so proportioned with reference to the section of the sample and to the extent of the air-gaps as to cause the induction to have a value fairly representative of transformer work. In a tester exhibited in operation before a meeting of the Institution of Electrical Engineers, the induction was about 4,000 C. G. S. units, with the normal size of test sample. By increasing or reducing the area of section of the sample the intensity of the induction may be reduced or increased. Within reasonable limits, however, the value of this intensity may be adopted in testing.

If a weight of a sample chosen is equal to that of seven pieces of this material as a general standard, it will suffice, in preparing other samples for testing, to select that number of strips which will give a weight even roughly approximating the standard weight. The nearest whole number of strips will do, and it is necessary to cut a narrow or wide strip to make up the extra weight. Regarding the question of calibration, an exhaustive series of experiments has been made to determine to what degree of accuracy the readings of the magnetic tester correspond to the hysteresis losses as found by ballistic tests for various samples of iron. A comparison showed that these tests accord well, and that the scalereading of the magnetic tester is nearly proportional to the hysteresis loss. The hysteresis of the standard samples being stated for a given induction, to find the hysteresis for any other induction it is only necessary to use a table of factors, deduced by the author as a general mean from many ballistic samples.

The Velocity of Electricity.

THE present period is one in which the replacement of long-standing hypotheses and conceptions by newer and more scientific ones is slowly, but surely, going on. It is easy to understand how in the infancy of any branch of science, in the attempt to express that which is new, terms may be adopted which, in the light of subquent progress, become so burdensome that they must be abandoned. Because electrical energy was seen to shift its place along a conductor, and because the first conception was that this energy was confined to and within the conductor (in which case there would be an analogy between the flow of a fluid through a restraining and directing channel and the electric flow), the idea of an electric current was conceived. This term is still used for want of a better; but every one at all conversant with the facts perceives its utter inadequacy. It does not fit the facts. When we speak of the velocity or rate of flow of an electric current, we express no clearer idea of the phenomenon than if we spoke of the velocity of electric projectile. Still the terms "electric current" and "electric fluid" have a working value. Like the term permanent gas in physics (although we have learned in recent times that there is no gas yet discovered that is permanent under all possible conditions), the use of the words current and fluid enable us to express modes of action that, without them or their equivalents, we could scarcely discuss at all. They may be regarded much in the way that symbols of unknown quantities are regarded in algebra. By their use we can express their mutual relations without at all knowing the real value or physical significance of what they represent.

With reference to the velocity of electricity the present want of knowledge is well expressed by Mr. Gifford Le Clear in *Popular Science Monthly* for March, when he says it is at present "generally conceded that the velocity may be anywhere from the fraction of an inch per hour to millions of miles per second." An attempt made years ago to find the velocity of electricity considered as a fluid, by timing the transmission of a signal sent from Harvard Observatory to St. Louis, and dividing distance by time, is shown to have been entirely misleading in its results. The reason for this is found in the reaction between the current flowing in the wire and the magnetic field created around the wire by the current.

Artesian Well Power Utilized for Electric Lighting.

IT is only within a very recent period that the streams thrown with force from artesian wells have been used in a tentative and limited way for generating power. *Western Electrician* (March 7) describes an instalment for electric lighting in Chamberlain (county seat of Brule county, South Dakota), driven by artesian well power, which may fairly be said to be the first application of this species of power in a permanent power plant large enough to warrant one in considering the experiment a real beginning. True, this drives only a five hundred-light dynamo at present, but it clearly demonstrates possibilities worth considering in many localities.

When water was struck, it was found that the delivery of the well was 4,432 gallons per minute, at a pressure of 110 lbs. per square inch; and the available power has been estimated as 100 h. p., constantly exerted. When the water delivery is confined and directed by a 2¼-in. nozzle, it rises to a height of 162 ft.

"The mechanical means employed to utilize and control the power are simple, but effective. An eight-inch ell was attached to the top of the casing of the well, and fifty feet of horizontally-placed eight-inch pipe conveys the water from the connection to the power-house. Here the volume of water is reduced to a stream about three inches in diameter, which impinges on the buckets of a Pelton water-wheel. This wheel is mounted on a shaft carrying a large driving-pulley, which is directly belted to a 500-light alternator, built by the Royal Electric Company of Peoria, and operating at 1,100 volts. A small exciter is driven from the armature shaft of the large machine. The power is more than sufficient to run the plant to its full capacity, and the five hundred lights are all taken in the city."

Raising or lowering the nozzle regulates the power. "The secondary circuits of the wiring system are operated at 52 volts, and the lamps are constantly kept up to this pressure without difficulty. The lights at present are run from sunset until midnight, and from 4:30 A. M. until sunrise, and by next fall the company expects to have the residences of the city take enough light to warrant all-night running. At present much of the power is going to waste, and steps are being taken to put it to use by running other manufacturing plants, and thus utilizing the full force of the well night and day.

"The well of the Chamberlain Electric Lighting company is said to be the largest artesian well in the United States controlled for power purposes. The well is 675 feet deep and 8 inches in diameter. It is composed of sections of 8-in. iron pipe, inside of which is a 60-ft. length of 6-in. slotted pipe, at the bottom, to prevent the ingress of rocks or other large substances with the flow of water. For a depth of 470 ft. from the surface the main pipe is encased in 10-in. pipe to strengthen it and prevent possible leakage. Both sizes of pipe are firmly seated on layers of granite. Three or four strata of this rock, from 4 to 8 feet thick, of exceptional hardness, were encountered in putting down the well. This granite was the most obdurate that had thus far been encountered in the well region, and it required from two to three weeks' drilling, day and night, in each case, to get through five or six feet of it." This an interesting, and in some respects unique, installment.

Municipal Undertakings.

THE Rochester, N. Y., *Post Express* handles the project of purchasing an electrical plant to furnish light for the new court-house in that city without gloves. It makes no plausible distinction between such a municipal enterprise and the broad question of public control of business enterprises.

"Those who take an active part in politics see their advantage in such a development of government activity; even the honest may view with complacency the increase of political patronage, and for the dishonest there is a greater possibility of illicit gains.

But experience shows that whoever may profit by government control of business enterprises, it is not the public. It is easy to say that if individuals reap a benefit from such undertakings, the public can do the same, but this by no means follows. There is no business of which the profit is sure; where gain results, it is because the enterprise is managed with judgment, with intelligence, and with economy, and, most important of all, because it is managed by those who have their own money at stake.

In all these respects the government is at a disadvantage; its servants are constantly changing, and they assume a brief charge of industries to which they have not given their lives; the only margin of profit is by a rigid economy of operation, and until human nature changes there will be few who insist upon economy when the public is the paymaster. It is for these reasons that, with few exceptions, when the government assumes control of a private enterprise, the public gets poorer service at higher cost. This is not a matter of speculation; it has been demonstrated by experience.

When we compare systems controlled by government with our own railroads, which are exclusively in private hands, we find that we are carried quicker, cheaper, and with greater comfort.

There are a few English and Scotch towns which have enlarged the scope of municipal action with advantage to the citizens; they are exceptionally situated and exceptionally governed.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Applied Electricity in the American, English and British Colonial Electrical and Engineering Journals—See Introductory.

Lighting.

*4811. Islington Vestry Electricity Supply Works (An illustrated description of a new electricity supply undertaking, embodying the achievements of the highest technical skill. The principal feature is the provision that has been made for easy extension and increase in capacity of the station). Elect Rev, Lond–March 6. 12000 w.

*4813. High-Voltage Lamps, and Their Influence on Central-Station Practice. G. L. Addenbrooke (Paper read before the Inst. of Elec. Engs. The first part considers the possible sources of influence on central station practice, and the life of high-voltage lamps). Elec Eng, Lond–March 6. Serial. 1st part. 2700 w.

*4817. Bristol Municipal Electric Supply Station (Description of the details of the station, its outlying network of mains and sub-stations, with history and early stages of development. Illustrated). Elect'n–March 6. 5800 w.

4904. Quick Methods of Testing for Faults in Electric Wiring. A. E. Hutchins (Directions for testing). W Elec–March 21. 1700 w.

*4906. An Interesting Plant. S. D. Benoliel (A small plant run by a combination of water and steam power at Riverhead, L. I. Illustrated description). Elec Pow–March. 3000 w.

*4923. St. Pancras Electric Lighting (Illustrated description of the King's-Road refuse destructor and electric lighting station). Eng, Lond–March 13. Serial. 1st part. 1500 w.

4948. Incandescent Lamp Efficiency. W. Stuart-Smith (Considering methods of maintaining their efficiency). Jour of Elec–Feb. 1800 w.

4949. Electrical Search-lights in Sea-coast Defense. John T. Thompson (The benefits to the defense from the use of these lights with general information). Elec Engng–March. 1200 w.

5002. Electricity in Algeria (Illustrated description of interesting installation in Tlemcen, Algeria). W Elec-March 28. 900 w.

5113. A New Method of Studying the Light of Alternating Arc Lamps. W. L. Puffer (Abstract of a paper read before the Am. Inst. of Elec. Engs. Describes experiments). Elec Eng–April 1. 600 w.

5138. The Electric Lighting Plant in the American Surety Building (Illustrated description). Elec Wld–April 4. 1200 w.

*5180. Elecric Wiring (Remarks on the systems used, their expense and the reasons for using them, with some references to the papers of Mr. Fred. Bathurst, and Mr. Sam Mavor). Engng–March 27. 1600 w.

*5192. The Economical Current Density for Electric Light Mains. James Whitcher (Discussing questions involving points of doubt and difficulty that arise in the application of Lord Kelvin's law for the most economical current density for electrical distributing mains, particularly as they affect electric lighting). Elect'n–March 27. 2800 w.

5218. Electric Lighting in a Pioneer Town. J. W. Dickerson (Description of the plant which has made Cripple Creek a well lighted city and thus contributed to the order which prevails. An account is also given of the proposed installation of a power plant as an addition to the station). Elec Wld–April 11. 1600 w.

Power.

4740. The Generation and Distribution of Current by an Edison Station. J. W. Lieb, Jr. (Read before the New York Electrical Society. The progress made in industrial applications of electricity is shown by a comparison of the details of equipment of the station of 15 years ago, with that of to-day). Elec Rev–March 11. 4700 w.

4805. A Cotton Mill Electrical Transmission Plant. A. F. McKissick (Illustrated description of the installation of the Pelzer Mfrg. Co., of Pelzer, S. C.). Elec Wld–March 14. 1300 w.

4836. Development of Electric Lighting Engines. H. Lindley (Abstract of a paper read before the Northern Society of Electrical Engineers). Elec–March 18 3000 w.

4842. Distributing Power and Light from Single Phase Alternators. Joseph N. Mahoney (The object of this paper is to show a method of utilizing the present simple alternating apparatus for the generation and distribution of power and light by polyphase currents with no more complication than that met with in a three wire direct current system). Elec Eng–March 18. 900 w.

4847. The Direct Connection of Electric Motors with Machines of Various Types. William Baxter, Jr. (A consideration of the advantages and disadvantages). Elec Wld–March 21. Serial. 1st part. 1600 w.

*4909. Design of Dynamos. G. F. Sever (Lecture delivered before the Henry Electric Club. Treating of the elements of good design and bringing to notice points not often considered in text-books). Elec Pow–March. 2500 w.

*5031. The Development of Electrical Traction Apparatus in the United States. H. F. Parshall (The more important details of the machinery especially developed for use in electric traction are discussed and illustrated). Jour of Soc of Arts–March 20. 6800 w.

*5058. On Secondary Batteries for Electrical Locomotion. Desmond G. Fitz-Gerald (The first part discusses the objections from weight in accumulators used for car propulsion and their application for the motive power of the heavier class of vehicles). Elec Rev, Lond–March 20. Serial. 1st part. 2500 w.

†5063. The Evolution of the Storage Battery. Maurice Barnett (An interesting and instructive paper reviewing the progress of the storage battery and followed by an extended discussion). Jour Fr Inst-April. 8800 w.

5139. Notes on General Electric Alternating-Current Machinery (Illustrated description of the latest types of alternating machinery). Elec Wld–April 4. Serial. 1st part. 1800 w.

*5199. The Regulation of Pressure and the Reduction of Light-Load Losses in Alternating-Current Systems of Electric Supply. E. W. Cowan and Alfred Still (Paper read before the Northern Society of Electrical Engineers, England. The object of the first part of the paper is to set forth what is believed to be the best methods of maintaining constant pressure in all parts of a distribution system under varying conditions of load). Elec Eng, Lond–March 27. Serial. 1st part. 3000 w.

5220 Electric Fans. S. D. Mott (Illustrated description of ventilating fan). Elec Wld-April 11. 600 w.

Telephony and Telegraphy.

4807. The Berliner Microphone Patent Suit. Ill. (The bill of complaint—Berliner's first application and disclaimer). Elec–March 11. 2200 w.

4841. The Swartz "Multiple Rival" Telephone Switchboard (Illustrated description). Elec Eng–March 18. 500 w.

4846. Telephone Construction in the Rocky Mountains. J. W. Dickerson (Illustrated description of the system of the Colorado Telephone Co). Elec Wld–March 21. 1200 w.

5111. Horton's Telegraph Repeater (Illustrated description). Elec Eng–April 1. 1000 w.

5122. Twenty Years' Progress in Telephony. John C. McMynn (Abstract of paper read before the Chicago Elec. Assn. Historical account). Elec–April 1. 2800 w.

*5193. On Telephonic Disturbances Caused by High-Voltage Currents. V. Weitlisbach (Translated by C. S. du Riche Preller. The paper is a report just published at Berne—*Blätter für Electrotechnik*). Elect'n–March 27. 4500 w.

*5198. Telephone Exchanges and their Working. Ill. Dane Sinclair (Paper read before the Inst. of Elec. Engs., London). Elec Eng, Lond–March 27. Serial. 1st part. 1500 w.

5219. Telephony and Involved Interests. E. F. Frost (A discussion of the conditions affecting the telephone interests, especially as they relate to the press). Elec Wld–April 11. 1400 w.

5223. Regulation of Telephone Rates. J. E. Keelyn (A discussion of telephone rates. The writer holds that a combination "flat" and "sliding scale" rate should be applied to the public exchanges. The abuse of free telephones is also discussed). Elec–April 8. 2000 w.

Miscellany.

4835. The Electrical Combine (Editorial on the combination of the General Electric Co. and the Westinghouse Co). Elec–March 18. 3000 w.

4843. Can an Electric Circuit Be Opened Without an Arc? A. J. Wurts (Results of experiments made with a view to arc suppression in switch contacts). Elec Eng–March 18. 1000 w.

4862. Separable Armature Coils. Ill. William Baxter, Jr. (Their shape and construction; also their advantages and disadvantages). Am Mach–March 19. 2300 w.

*4905. Notes on Protection Against Lightning Collected During the Summer of 1895. A. J. Wurts (Notes taken during the summer of 1895, for the purpose of obtaining information regarding lightning arresters on the McKeesport and Wilmerding Railway). Elec Pow–March. 1000 w.

*4907. Principles of the Magnetic Field. Frederick Bedell (A study of the magnetic circuit, giving particular attention to its action in connection with alternating currents, as given in the first number). Elec Pow–March. Serial. 1st part. 2800 w.

4937. How the Electric Current is Generated. Sydney F. Walker (Traces the generation from the energy stored in coal or water, through its various conversions). Am Gas Lgt Jour–March 23. 1800 w.

*4942. Paralleling of Alternators. Robert Hammond (Abstract of paper read before the Northern Soc. of Elec. Engs. The latest information on this much discussed subject). Elec Eng, Lond–March 13. Serial. 1st part. 4800 w.

4957. Electrical Engineering at the University of Nebraska. T. C. Martin (Illustrated description and historical account of the University; its departments are treated separately and much interesting information given). Elec Eng–March 25. 3500 w.

4959. Removal of Wires in Boston. Ill. (Abstracts from the report of Commissioner John R. Murphy, giving some details relating to the work done by the various wire companies). Elec Rev–March 25. 3200 w.

4996. A Simple Method for the Measurement of Electric Current. Ichiro Goto (Method for measuring current requiring only a scale, and magnetic needle). Elec Wld–March 28. 300 w.

*5057. Testing Secondary Cells (A review of some points of scientific interest, relating to secondary batteries brought out in a case tried recently in the London courts). Elec Plant–March 1. 5000 w.

5060. On Electrical Discharges Through Poor Vacua, and on Coronoidal Discharges. M. I. Pupin (The first part is an introductory with brief description of the experimental method). Elec Age–March 28. Serial. 1st part. 700 w.

5114. Sparking of Closed Coil Direct-Current Armatures. George T. Hanchett (Discussion of the subject, the causes and remedy). Elec Ry Gaz–March 28. 2300 w.

5141. Simple but Effective Electric Fountain (Illustrated description of the fountain in the large department store of Siegel, Cooper & Co., in Chicago). W Elec–April 4. 600 w.

INDUSTRIAL SOCIOLOGY

The Telegraph Monopoly.

In the third part of a series of papers by Professor Frank Parsons under the above title (*The Arena* for March) a mass of statistics presented in proof of the assertion that the Western Union Telegraph Company defrauds the public by watering its stock commands attention. If these statistics be accepted as valid, the extent to which this practice has been carried will account for much of the wealth which the late Jay Gould was enabled to bequeath.

From these figures it appears that the company has issued "sixty millions of stock for ten millions of investment in the purchase department," and that, if the same rule has governed the dividend department (which Mr. Parsons seems to regard as most probable), "the present capital stock of ninety-five millions represents a total expenditure of about sixteen millions of dollars, which, added to the fifteen millions of bonds (raised at various times to cover expenses that could not be met with stock), makes the grand total of thirty-one millions as the actual cost of the Western Union system."

Prof. Parsons then proceeds to estimate what would be the actual value of this property, if it were in good condition, which he declares is not the case; and, from data which he gives, he finds this value to be about twenty millions, inclusive of lines, patents, instruments, and appliances.

"The bondholders own fifteen millions of the plant, and five millions is all the physical value that is left for the stockholders. After paying six per cent. on the bonds, the public should not be asked to pay the stockholders more than six per cent. on five millions, for that is substantially what they own of the plant above the mortgage, and they have no moral right to ask the public to pay interest on the franchise which was created by the public and is kept alive by its patronage. The expenses of the business, including depreciation, plus a fair interest on the value of their investment, is all they have a right to ask. The public contributed the franchise on which a value has been placed of about ninety millions out of a total one hundred and ten millions, so that, on the principles of parnership, the public ought to get $\frac{9}{11}$ of the profits." He next proceeds to consider the question of profit.

"Justice gives fair remuneration to labor, and a reasonable profit to the capital actually entering as a factor into present production. The ordinary corporation, however, cares nothing for justice. It takes all it can get. For 1895 the Western Union reports $6,141.389 profit, and $1,578,584 paid in rentals for leased lines, part of it for ocean lines, leaving it about seven millions of profit for the land plant. Interest on bonds was $893,821, wherefore more than six millions remain as profit on less than five millions of property,—the portion of the plant not covered by the bonds. One hundred and twenty per cent. is a pretty good profit, but it is nothing for the Western Union. In 1874 the dividends amounted to 414 per cent.; the investors got their money back four times in one year. During the war, when patriotic citizens were giving their lives and their money for the service of the public, the Western Union was squeezing the public with all its power, and paying one hundred per cent. dividends a year, not merely on actual investment, but on the total stock,—water and all. Since 1866 the receipts have been four hundred and forty millions; profits reported as such, one hundred and thirty-seven millions, which rises to one hundred and sixty millions with the profits put down under the head of rentals, and to more than two hundred millions with the profits expended in buying rival lines that wouldn't take Western Union stock,—at least President Green tells us that the company has spent more than sixty-one millions in cash to buy opposition lines, and, as the balance sheets show that these sixty-one millions did not come out of reported profits, they must have come out of unreported profits, except so far as provided for by the bonds. There are other additions to be made on account of new construction put down to operating expenses. It is impossible to ascertain precisely the sum total of Western Union profits; even if all the items were reported, it would not do to be too sure they were correctly stated, for corporation bookkeeping is a very flexible affair. There seems, however, to be good reason to believe that at least half the receipts have been profit. And these millions have in a large part been received by men who put almost nothing into the plant. It is probable that the stockholders of the Western Union proper never paid in a half million dollars from first to last. And John Wanamaker says that 'an investment of $1,000 in 1858 in Western Union stock would have received, up to the present time, stock dividends equal to $100,000, or 300 per cent. of dividends a year.' Think of it! Getting your money back a hundred times in cash, and fifty times more in good interest-paying property!"

"A reasonable merchant, manufacturer, or landlord is satisfied to pay for his property himself, and get ten per cent. profit on his capital, out of which profit or other capital of his own he expects to make any improvements his business may require. The Western Union man, however, expects the public to pay for his plant and all improvements upon it, and give him three hundred per cent. a year besides. How long are you going to stand that sort of business, my brothers? And even this is not quite all; the Western Union man likes to get a bonus out of the government, when he can do so without awaking the people, and he has sometimes succeeded in getting a bonus that all by itself would pay five times the cost of the line for which it was given."

The Baltimore and Ohio Railroad Relief Department.

THIS department having been in operation fifteen years, a fair judgment of its practicability and utility can now be formed from details and statistics presented serially in *The Railroad Gazette* by Mr. L. W. Reilly (commenced in issue of March 20). The following abstract includes a few of the many interesting facts detailed by Mr. Reilly.

"At the start, the company assumed general charge of the department. It provided office-room and furniture; it gave the services of managers and clerks; it granted the use of its facilities; it became the custodian of the funds; and it guaranteed the faithful performance of the obligations of the enterprise.

"The department is controlled by a special committee of directors of the company. They are aided by two advisory committees, one for the lines east of the Ohio river, and one for the lines west of that stream. These advisory committees each consist of seven members,—the general manager of the road for that division and two employees from the machinery department, two from the transportation department, and two from the road department, elected by their fellow-members. Subject to these committees, but in direct management of the relief department, are a superintendent, an actuary, and a force of clerks.

"The department is divided into three sections, called the relief, the savings, and the pension feature.

"The relief feature affords relief to its members when they are disabled by injury or sickness, and to their families after their death.

"The savings feature affords opportunity to the railroad employees and their near relatives to deposit with it their savings, and earn interest thereon; and to employees only it offers to lend money at a moderate rate of interest and on easy terms of repayment, for the purpose of acquiring or improving a homestead or freeing it from other debt.

"The pension feature makes provision for those employees who, by reason of age or infirmity, are relieved, or retire from the service of the company.

"The railroad contributes to the department every year the following amounts:

"(1) The sum of $6,000 for the support of the relief feature, or, when not needed for that feature, for the support of the pension feature;

"(2) The sum of $25,000 for the support of the pension feature;

"(3) The sum of $2.500 for the physical examinations of employees."

Membership in the relief feature is voluntary for officials paid more than $2,000 per annum; for employees continuously in the service of the company since May, 1880, and who are not members of the Baltimore & Ohio Employees' Association; clerks; telegraphers in the service; agents receiving commissions; and employees receiving $20 per month or less. Upon all other employees of the road, even those who are under instruction without pay, membership is obligatory, except upon temporary and extra help employed for not more than two days. A medical examiner passes upon the surgical condition of applicants, and the limiting age for admission is forty-five years. There are other important restrictions, limitations, etc., for which those desiring fuller information should consult Mr. Reilly's well-prepared paper.

Members are classified according to the character of their employment, and the general classes so formed are subdivided with reference to their average monthly pay. Members in these classes pay monthly dues ranging from 75 cents to $5, according to their classification. Except where injury or sickness are contributed to by bad personal habits or immoral conduct, members are entitled to benefits as follows:

"First.—Payments while totally disabled by accidental injury received in the discharge of duty in the service, for each day other than Sundays and legal holidays, during a period not exceeding twenty-six weeks at the rate of fifty cents a day for a member of the lowest class, and at higher rate for members of the other classes in proportion to their contributions; and at half these rates during the continuance of the disability after the first twenty-six weeks.

"Second.—Payments while totally disabled by sickness or from any cause other than accidental injuries received in the discharge of duty in the service, for each day other than Sundays and legal holidays, after the first six working days of such disability, and for a period not exceeding fifty-two weeks, at the rate of fifty cents a day for a member of the lowest class, and at higher rates for members of the other classes in proportion to their contributions.

"Third.—Payment on the death of a member of the lowest class from accidental injuries received in the discharge of his duty in the service, of $500, and of greater amounts for the other classes in proportion to their contributions.

"Fifth.—Payment of fees for such surgical attendance as the company's medical examiner approves as necessary in consequence of accidental injuries received in the discharge of duty in the service, at the rates fixed in a schedule adopted by the relief department, when the bills therefor are approved by the local medical examiner. The superintendent will arrange for the admission of members to hospitals, at moderate cost, when requested."

Both the savings and the pension features of the department are worthy of careful study, but they cannot be here outlined. All details of the three features appear to have been thought out in the most careful manner, and the system is obviously an intelligent and well-directed effort in the true line of industrial progress.

High Price of British Consols.

British consols sold in February at the highest price recorded up to that date. The 2¾ per cents. sold for 109, notwithstanding the fact that they are to become 2½ per cents. in 1903.

Commenting editorially upon this significant fact, Bradstreet's (March 7) first notes that such an investment can yield to the investor only £2 7s. on the £100, and remarks that this indicates "the extremes to which British capital is forced in order to obtain absolutely safe employment." It also notes a corresponding effect upon

English and Scotch railway shares and debentures. *The Financial News* (London, Feb. 18) is then quoted with reference to the probable future interest which British consols will yield.

"It seems highly probable that in a few years consols will be valued on a two per cent. basis. While, to some extent, we may be proud of the apparent advance in the national credit, it is a mistake to suppose that the price of consols is a trustworthy test. If the quotations of government securities were the real criterion of credit, we should hardly see a similar improvement in French and German *rentes*, notwithstanding that the indebtedness of both countries is growing at an uncomfortably rapid rate. The reason of the rise in government bonds almost all over the world—that is, among those nations which have not openly defaulted or given evidence of bad faith—is the ever-increasing demand for fairly safe securities, which must continue to grow as the accumulated wealth of the world increases. In our own country [England] there is additional reason for the advance in consols, because the demand is automatically augmented year by year on account of the savings banks, while the supply is steadily diminished by the operations of the sinking funds. Unless the scope of investment should be enlarged, it is obvious that the funds of the post-office savings bank will soon drive consols to a still more extraordinary price than that at which they stand now, provided that conditions are not changed by war, or any other event which would involve England in a heavy outlay. But, leaving consols out of the question, the lower rate of interest now obtainable in all gilt-edged securities is clear proof that demand has so far exceeded supply that investors have educated themselves to be content with a smaller return than that which was considered the irreducible minimum not many years ago."

Bradstreet's finds a curious contrast in the following: "Not so long ago a leading financial authority declared that it was dangerous to buy consols at 102." Now, the *Financial News* thinks it dangerous to sell them at 109. The same journal, commenting upon the fact that, at the date of its article, the official minimum of the Bank of England had stood at 2 per cent. for practically two years without alteration,—"a longer period than has ever been known since the bank act was passed in 1844."—asserts that "even this figure does not represent the real value of money" during the term since the reduction of the rate to 2 per cent. (Feb. 22, 1894.)

"Hardly at any moment has the open market rate for three months' bills approached 1½ per cent., and that in spite of many occurrences which tended to raise the value of money, at least temporarily. A year ago, for example, the issue of part of the United States loan in Europe led to the expectation that large quantities of gold would be shipped to New York. But our supplies of bullion were replenished from other quarters to such a degree that the market hardly felt the influence of the comparatively moderate drain of gold to the United States. Since then, the South African boom gave rise to considerable demands for accommodation, but without much effect on the market. When the boom began to reach dimensions inconsistent with safety, some of the banks diminished the advances made by them to the Stock Exchange, and so helped to precipitate the collapse. The trouble which followed in some continental centers reacted to a slight extent on the London money market, but rates did not stiffen much. But it is needless to dwell on the fact that outside rates for money have been almost as consistently low during the past two years as the bank rate has been."

From these causes the rise in other high-class securities—debentures and preferred stocks of railways—has paralleled that of consols. "Consequently much attention has been given to the ordinary shares of home railways, and at the present London & Northwestern's common stock, which in 1895 paid 6⅜ per cent. dividends, sold at 187⅜ in last September, against 185½ in 1890, when the dividends on the stock amounted to 7¼ per cent. Other examples might be cited, showing that the English investors have to be satisfied with no more than 3 per cent. from home investments." The undeniable tendency of English capital to increased investment in American securities is thought to be fully accounted for by the facts stated.

The Recent United States Loan.

It is interesting to note the light in which the financial system of the United States and its workings are regarded in the great financial centers abroad. The recent United States loan, which, as we think, was compelled by this defective system, and the temporary, make-shift character of the loan form the text of some plain-speaking in the March number of the *Banker's Magazine* (London).

The loan is, in one sense, considered a success, since the bids for it aggregated several times the amount called for; but the opinion is expressed that its effect in maintaining treasury reserves is likely to be even more transient than was the case with the preceding loan, notwithstanding the fact that the last loan exceeded the former one. The difference between the two operations is explained as follows:

"The loan of 1894 was taken entirely by the Rothschild-Morgan syndicate, who placed one-half of it in England and the remainder in the States. Not only did the Rothschild-Morgan syndicate undertake to deposit in the United States treasury a certain amount of gold obtained from abroad, but for a given period they pledged themselves to protect the treasury reserves in every possible manner. The issue of bonds placed on this side was so contrived that it was practically impossible for them to be returned to the States for a period of six months. No sooner, however, had the period of the syndicate 'protection' expired than withdrawals from the treasury recommenced, until, prior to the new loan last month, practically the entire sum raised by the loan of 1895 had been lost. Was there ever a more complete picture of financial schemes being hopelessly spoiled by an unsound and illogical currency system?

"And now it would seem that a further striking object-lesson is to be afforded by this latest device for replenishing treasury reserves. Twenty millions sterling have been raised without the assistance of a protective syndicate, and the treasury reserve has been raised to ninety-four million dollars. Confidence, we are told, is returning, while in the same breath we are informed that greenbacks are at a premium. In other words, there is a rush to withdraw the very gold recently deposited. Whether this latest object-lesson in United States finance will be sufficiently convincing to bring home to the nation the impossibility of maintaining their present gold standard on the present illogical currency is a point which may now attract attention. If it does so, that lesson will scarcely have been dearly bought, even at the cost of the recent heavy and almost useless loans."

Arguments for Reciprocity Treaties.

The advisability of reënacting a reciprocity provision, empowering the president to negotiate reciprocity treaties with foreign governments, having been for some time under consideration by the ways and means committee of the house of representatives, this committee addressed a circular of inquiry to several thousand manufacturers in the United States, designed to ascertain the consensus of opinion of leaders of industry upon this important measure. *The Iron Age* (March 26) prints abstracts from a considerable number of these replies, prefacing them with the statement that more than ninety per cent. of them favor such legislation. Such unanimity of opinion upon great public questions is rare. The replies indicate a high order of capacity to grasp public questions on the part of this class of citizens, and suggest the thought that, if it could be made to replace the present grade of statesmanship pervading our legislative halls, the welfare of the country would be promoted.

In many of the replies the tariff question is discussed in connection with reciprocity, and in some of the answers the subsidizing of steamers carrying goods to foreign countries is also advocated. In general, the replies are direct and pointed. Most of them comprise some mention of the business with which the writers are specially connected, and of effects upon this business of previous tariff and reciprocity legislation. We quote some of the abstracts as fair samples of their general tone.

"The Passaic Mill Company, Paterson, N. J., manufacturers of structural steel and iron, and bridge builders (capital, $2,000,000; 1,000 persons employed; annual product, $2,000,000), say: 'Our foreign trade is naturally through commission houses. The removal or reduction of customs imposed by foreign nations upon our merchandise would restore to us a large business enjoyed a few years ago. By reason of better designs and more economical use of materials we can overcome a difference of twenty-five per cent. in the cost of materials used in construction. The facilities for production in our line of business are such as to produce double the consumption when all manufacturers in our line are producing to their full capacity, leaving fifty per cent. available for export. This is the principal cause of trouble among American manufacturers. The effect of the reciprocity treaties of 1890 was excellent, and the repeal disastrous.'

"Central Iron Works, Pittsburg, Pa., makers of iron and steel boiler plates, for structural work (capital, $500,000; 350 persons employed), say: 'We do not have foreign competitors. Our prices must be kept where they will not allow foreign products to come in. The total product in our line has increased in the past six years. Our domestic markets will not consume more product, and we ought to have foreign markets to go to. There was no result as to our product from the reciprocity treaties of their repeal, but we are in favor of general reciprocity legislation.'

"The Peerless Manufacturing Company of Louisville, Ky., manufacturers of fireplace furniture (capital, $200,000; 300 employees: value of annual product, $200,000), say: 'Have made direct efforts to extend the foreign trade by circulars and catalogues. A duty of thirty-five per cent. in Canada enables foreigners to steal our patents and make the goods cheaper than we can produce them. Our trade has increased sixty per cent. in the past six years. Our greatest competition is in Canada and England. We can compete with the world in quality, and, if foreign duty tariffs were reduced, in prices. The business could be increased seventy-five per cent., if every access could be had to foreign markets. Reciprocity treaties were favorable to our export trade, and their repeal was an injury so far as foreign goods were introduced into this country in competition. We heartily favor the reciprocity principle as applied to future legislation.'

"The Detroit Steel and Spring Company, Detroit, Mich., say: 'The value of reciprocity arrangements between our government and other nations would be felt indirectly rather than directly. We are one of the largest producers of railroad engine- and car-springs. This product is sold largely to railroads to whom we give freight business, and the advantage which we have over competitors in the trade lies in the fact that we are able to reciprocate for any preference or favor shown us. We are strongly in favor of reciprocity, believing that the benefit derived will be felt by everyone of our five hundred employees as well as by our stockholders. We are large producers of material used by the agricultural implement-makers, who are becoming exporters of considerable magnitude, so that any arrangement for the increase of their export business would be at once felt by our company. The value of reciprocity can hardly be estimated between nations.'"

Most of those who have not experienced any material benefit from previous reciprocity legislation favor it, nevertheless, on general principles. Those who have thus gone on record as favorable to the proposed legislation comprise a majority of the leading manufacturers in the United States.

Limitation as a Remedy for Social Evils.

PROF. JOHN CLARK RIDPATH, in *The Arena* for April, attributes a great part of "the distress of the modern world . . . to the fact that there is established in society and over man no salutary and accepted principles of limitation." "There is," he says, "no rational and welcome doctrine as to the rules of restraint under which society and the organic life of man ought to be placed. Civilization seems thus far to have allowed its products to grow and run and clamber as they will across all fields, over all barriers, and up all heights, without regulation or wholesome pruning.

"If hitherto a limitation has been laid here and there upon the overgrowing exuberance of the organic life of man, it seems to have been laid in the wrong place, by the wrong hands, and with a wrong purpose. . . . The products of society, by the means adopted, have been warped and curtailed of their fair proportions, and man himself, even the thinking man, has come to dread the law of limitation, as if it were the suggestion of slavery or anarchism—according to the disposition of him who thinks it."

Professor Ridpath sees the "hints of limitation" both "in man and nature, . . . The natural limitations of life, however, do not much impede us; and if we are sound and sane they do not fret us at all." It is the misdirected and misplaced limitations that gall.

Professor Ridpath evidently thinks that a social state can exist in which the limitations are so laid that life in it may be far more easy and natural, contented and perfect, than is our present social life; and in a series of articles he proposes to discuss the limitatious which he thinks needful to secure this desirable result. The first part is devoted to landownership.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Industrial Sociology in the American, English, and British Colonial Magazines, Reviews and Engineering Journals—See Introductory.

*4734. Industrial Conditions and the Money Markets. Maurice L. Muhleman (Showing the effects of the financial crises and an unsound currency on the value of stocks and the development of industry). Eng Mag–April. 3500 w.

†4747. The Labor Party in Queensland. Anton Bertram (Historical and critical analysis of a great social movement which, though it is described as blind and incoherent, is compared with the independent labor party in the United Kingdom, and from this standpoint its achievements are startling. The article deals with conditions as well as results, with causes as well as effects, and is of great interest from beginning to end). Contemporary Rev–March. 9000 w.

†4749. Jesus the Demagogue. Walter Walsh (This paper is an able, just, and severe criticism of the modern tendency to regard Christ as a champion of democracy, and of the failure of this tendency to portray him as such, the result of the effort being rather to pose him as a demagogue. Instead of being a champion of the poor and oppressed, he is regarded as a savior of rich and poor alike, and his teachings were against the unrestrained selfishness of all classes of society. Instead of this the Christ of modern socialistic reform is a kind of sublimated Keir Hardie). Contemporary Rev–March. 5400 w.

4778. The British South Africa Company (Synopsis of the financial and material results of the operations of the company up to date). Bradstreet's–March 14. 900 w.

†4832. The Success of the So-called Popular Loan (The success, while gratifying, illustrates the principle that a popular loan draws from the gold resources of the country itself, whereas, if made through a syndicate, it could be stipulated that a portion of it should be imported). Banker's Mag–March. 1500 w.

†4833. Gold and Silver and the World's Money (An abstract, with voluminous tables, of a paper in the *Journal of the Royal Statistical Society*, by Mr. Lesley C. Probyn. The tables give estimates of money in countries where values are estimated in gold, in countries where values are estimated in silver, in countries where values are estimated in inconvertible paper, and in countries where values are estimated in monopoly rupees). Banker's Mag–March. 5000 w.

4860. The Labor Question in an English Foundry. R. A. Hadfield (A further contribution to the discussion of the relative merits of the system of payment by time, and payment by the piece, with other conclusions derived from experience in dealing with workmen, particularly in foundries). Am Mach–March 19. 2200 w.

4876. Responsibilities of Vocation. W. S. Penruddock (Discusses ancient and modern methods employed to prevent impositions by manufacturers upon customers, in the sale of manufactured articles). Age of St–March 14. 2000 w.

4881. A Railroad's Relief Department. L. W. Reilly (Believed to be the most complete account of the Baltimore & Ohio Relief Department and its results that has yet appeared). R R Gaz–March 20. Serial. 1st part. 2200 w.

4900. The Economic Aspect of the Transvaal Rebellion. C. (Reduction of gold output, diversion of the stream of emigration, and disturbance of commerce in which the mercantile interests are suffering, are topics discussed). Bradstreet's–March 21. 1500 w.

*4952. The Quarrel of the English-Speaking Peoples. Henry Norman (An exceedingly powerful plea for peace and a lucid portrayal of the folly of war for any cause between England and the United States. It is pointed out that the United States is in no danger from British encroachments upon territory in the Western Hemisphere, but has seeds of mischief in her own borders which, unless attention of statesmen and patriots is soon directed to them, will be fruitful of sorrow for the great republic. It is intimated that the most terrific conflict between the "Haves" and the "Have-nots" will take place on American soil). Scrib Mag-April. 4000 w.

4961. The Statistics of Wages and the Cost of Living (The seventh and closing lecture in the special course on Social and Industrial Statistics by Carroll D. Wright, U S. Com. of Labor, at the School of Social Economics, Union Sq, New York. Abstract prepared by J. B. Walker). Sci Am Sup-March 28. 1000 w.

4968. Reciprocity Treaties (Summary of replies received by the Ways and Means Committee of the House of Representatives, to a circular of inquiry sent out to manufacturers touching the desirability of re-enacting a reciprocity provision, empowering the president to negotiate reciprocity treaties with foreign governments. The consensus of opinion thus obtained is favorable to such legislation). Ir Age-March 26. 5000 w.

4969. Conservative Influences in Labor Organizations (Editorial. Relates to a growing conservatism believed to exist in labor organizations, not as the result of timidity, but having root in the consciousness of a strength which is recognized and respected. This tendency is regarded as a very hopeful sign of the times). Ir Age-March 26. 1300 w.

*4970. Limitation as a Remedy. John Clark Ridpath (The present instability of human society and disturbance of peaceful living is regarded as the result of greed for property and prerogative for which practical limitations have not been established. This serial is intended to urge the importance of speedily establishing such limitations. The first part deals with land ownership as the real bottom of all the issues about which men are contending and drawing the sword). Arena-April. Serial. 1st part. 6000 w.

*4971. Planetary Freebooting and World Policies. Richard J. Hinton (The greed of European governments for new territory is characterized as no better than brigandism. In view of this insatiable greed, the true policy and duty of the United States are declared to be the enforcement of the Monroe doctrine, and the neutralization of both the Atlantic and Pacific oceans making them free world highways. Our national record should be unquenchable hostility to the policy of imperial piracy). Arena-April. 2800 w.

*4974. Deficiency of Revenue the Cause of Our Financial Ills. John Sherman (A critique of that portion of the president's annual message relating to the condition of our national finances, and of the views of Sec. Carlisle, which are in accord with those expressed by Pres. Cleveland). Forum-April. 5300 w.

*4976. Holland's Care for Its Poor. J. H. Gore (Describes the organization and working of two institutions specially designed for the benefit and protection of the poorer classes; viz., the Postal Savings' Bank, and the Loaning or Pawn Bank). Forum-April. 4000 w.

*5008. The Tariff in Legislation. James Albert Woodburn (A brief résumé of the legislative history of the tariff, merely presenting the landmarks and indicating their significance). Chau-April. 4000 w.

*5009. The Protection of Italian Emigrants in America. Luigi Bodio (Translated for the *Chautauquan* from the Italian *Nuova Antologia*. Suggestions as to what may be done by the Italian government to protect emigrants who go to ports in the United States, with some reference to other countries). Chau-April 3000 w.

*5011. The Atlanta Exposition. Leonard Waldo (Historical account of this famous exposition. The first part describes the approaches and buildings). Engng-March 20. Serial. 1st part. 1600 w.

*5021. The Customs Tariff of Guatemala (List of alterations and modifications, as per a government decree reported by J. Frederick Roberts, British Chargé d'Affaires at Guatemala) Bd of Tr Jour-March. 2700 w.

*5022. Tariff Changes and Customs Regulations (Includes changes and modifications in Sweden, Germany, France, Indo-China, Belgium, Spain, Italy, Austria-Hungary, Japan, United States, Guatemala and British India). Bd of Tr Jour-March. 2800 w.

*5053. Engineering and Its Relation to the Labor Question. William Kent (Traces the relation between engineering and economic science, considering engineering as only an agent in increasing the wealth of mankind, and economic science only so far as it relates to the labor problem). Sib Jour of Engng-March. 2200 w.

5068. Labor's Value. W. S. Rogers (In the first part experience with different systems of wage paying is narrated. Incidentally gain-sharing and profit sharing are criticised). Mach-April. Serial. 1st part. 2400 w.

†5072. The Social Function of Wealth. Paul LeRoy Beaulieu (Translated from the *Revue des Deux Mondes*. Though the word "function" is used in the singular in the title it becomes plural in the treatment. Riches make their possessors leaders of men. Frederic Harrison's view that the first duty of capital is to take care of itself is adopted. The Christian maxim that the wealthy are the administrators of the poor is pronounced not wholly practicable from the human point of view; but the principle that the wealthy should be the economists of the poor is approved. One function of wealth is found in enterprises requiring patronage and remunerative philanthropy. But only income can be legitimately used. Gratuitous patronage of unremunerative works is another function. Still another is the foundation of public institutions). Pop Sci M-April. 2200 w.

*5074. Building Associations and Savings Banks (The competition of building associations with savings banks, the world over, as aids to economy is made the subject of comparison not only with the banks, but with other co-operative associations. Their increase in number and in membership is considered historically and philosophically, and the reasons for their prosperity are found, not only in the profits which exceed those obtained by savings-bank depositors, but in the safety of the investments and the simplicity of their systems). Gunton's Mag–April. 3800 w.

*5075. A Full-Weight Silver Dollar (Starts with the assumptions that no solution of the silver question is feasible on the basis of silver monometallism, and that, if the fight is forced on monometallist lines, the single metal will be gold. The argument then deals with the use of silver with gold, as the only solution of the question, the system also to comprise parity of value between silver and gold dollars). Gunton's Mag–April. 1800 w.

*5076. Restoring American Ships (Predicts that the protectionist policy will be promptly inaugurated on the approaching election of a republican president and a thoroughly protectionist congress in 1896 ; and that this policy will then be extended to American shipping, substantially in accordance with the provisions of the bill introduced in the U. S. Senate by Senator Stephen B. Elkins, drawn by Mr Alex. R. Smith, editor of *Seaboard* The bill is commended for its simplicity and moderation, and it is believed by the author that its effect will be the restoration of commercial activity in our merchant marine, with great increase of prosperity in all our seaport towns). Gunton's Mag–April. 2300 w.

*5077. Economic Aspect of Large Trading (The large department stores are considered as an advance step in the progress of civilization, and are welcomed and justified as such. This great change in the economics of commerce is the result of an inherent tendency to concentration of effort, and therefore cannot be successfully resisted. The advantages of such concentration are treated at some length). Gunton's Mag–April. 2800 w.

*5078. American School of Political Philosophy. Thomas S. Blair (The possibility of founding such a school, its usefulness, and the tendency of such an institution to aid in the establishment of rule by the progress-securing class,—in other words, a government of the labor class). Gunton's Mag–April. 1400 w.

*5079. The Myth of Stock Watering (A critique upon the series of papers, written by Prof. Frank Parsons, and published in the *Arena*, on the Western Union Telegraph Co. Mr. Parsons is charged with a vast amount of diseased and emotional distress in depicting the expansion of the investments of the company named). Gunton's Mag–April. 1800 w.

*5080. German Socialism of To-day (An account of the rise and progress of German socialism and a résumé of the legislative proposals periodically brought forward by German socialists, only to be laughed at or rejected by overwhelming majorities). Gunton's Mag–April. 1500 w.

*5103. Bimetallism (Editorial comments upon a recent speech of the British Chancellor of the Exchequer in the course of a debate in the House of Commons, wherein he seeks to show that gold has not appreciated in value, as many economists of the opposite school assert). Jour of Gas Lgt–March 24. 800 w.

5130. Recent Constructions of the Interstate Law (Editorial review of recent decisions of the United States Supreme Court, by which the decisions of the lower federal courts are reversed). Bradstreet's–April 4. 1500 w.

*5158. A Legislative Remedy for Labor Disputes. Herbert Armitage Drake (The usual statement of the problem in which labor is regarded as antithetical to capital is considered an insufficient generalization for stricter and more scientific requirements. The writer therefore restates it in terms which define a laborer as one who works with his muscles and a capitalist as one who hires labor at a profit. The question is, in brief, whether the profits of a business shall or shall not affect the wages of those employed in it. The main issue is a fair wage, and this it is proposed to settle by a court of chancery, wherein disputes can be settled by either party who may wish to bring suit, and wherein standing of the parties would be as in other law courts. The scheme comprehends a compulsory fund contributed by labor organizations for defraying expenses of litigation, thus reducing all labor disputes to an issue of fact in a private suit between responsible parties). Am Mag of Civ–April. 5500 w.

*5159. Martyrs of Industry. E. D. McCreary (Calls attention to the great sacrifices of human life entailed in carrying on the great industries of modern civilization, and while it is admitted that the greater part of these casualties are results of unavoidable dangers, it is charged that reckless carelessness, selfish greed, and outright inhumanity remain significant factors in the annual list of injuries and deaths in the occupations necessary to meet the wants of mankind . Am Mag of Civ–April. 3000 w.

*5160. The Periodicity of Commercial Crises as Exemplified in the United States. E. V. Grabill (The lessons derived from commercial crises, and their periodicity are the utility of credit in the machinery of commerce ; the full comprehension of the fact that all credit is founded upon confidence ; the equally significant fact that commercial crises result from temporary impairment of confidence ; and the importance of seeking to devise some system wherein there can be no means of destroying confidence. Historical sketches of the periodical commercial panics in the United States are given, in which loss of confidence was the result of unlimited speculation. In the author's opinion, the time will come when forcing up the prices of stocks and selling out under false pretences will be made a high crime). Am Mag of Civ–April. 3800 w.

5182. The Basis of Piece Work Systems (Editorial review of a paper by Mr. G. L. Potter, read before the Western Railway Club at its March meeting. Discusses vital points necessary to the success of the system, and expresses the opinion that piece work is to be the system of the future). Ry Rev–April 4. 1400 w.

†5225. The Reciprocity Will-o'-the-Wisp (Editorial on the foolishness of waiting for congress before making an effort to find customers in foreign markets). Ind Rub Wld–April 10. 1100 w.

MARINE ENGINEERING

Rates of Speed and Rates of Freight.

One of the most important of recent papers upon marine subjects, and intimately related to marine construction, was read by Mr. John Inglis before the Institution of Engineers and Shipbuilders in Scotland (Feb. 25). The object of this paper (of which we find an abstract in *The Engineer*, Feb. 28), as stated by the author, was "to show under what conditions of speed, cargo, and despatch it was possible for an ocean steamship company to pay the modest dividend of five per cent. to its shareholders."

For the convenient elucidation of the relation which possible profit bears to the conditions named, the author assumed "a ship of about ten thousand tons gross, differing from all other ships in possessing the remarkable property of a variable displacement on a given draught: that is to say, she alters her form and becomes finer and finer as the power of her engines and the desired rate of speed is increased; or otherwise, let there be an infinite number of such steamships differing from each other in form by very minute gradations. Then we are to suppose that the shipowner can choose any rate of speed he likes, without thereby affecting the volume of his business, his hand not being forced in any way by competitors; also, that he can always fill his ship with cargo to its utmost capacity, and that the number of passengers is the same, on the average, whatever time the ship takes over her voyage.

"Let us first take the case of a voyage out and home between two ports exactly three thousand miles apart, performed at average speeds varying from fifteen knots to twenty-one knots. Our steamer is assumed to have a displacement of eighteen thousand tons when adapted to the 15-knots rate, and, for every knot added to the mean speed at sea, six hundred tons is taken off the displacement."

These premises were followed by a demonstration of the time which could be saved on a voyage of the assumed length by increase of speed as follows. Increase from 10 to 20 knots effects a saving of 6¼ days; increase from 20 to 30 knots results in a further saving of 2 days and 2 hours; and increase from 30 to 40 knots a still further saving of only 25 hours. Of course, the higher speeds here named are impracticable, the maximum speed practicable for the assumed vessel being estimated by Mr. Inglis as 21 knots. The minimum average time a vessel must lie in port, added to the actual time of transit, determines the number of annual voyages she can make. But the cargo which can be carried also has a relation to the speed of running. The minimum time for remaining in port to discharge and put in cargo Mr. Inglis estimates to be 7 days, for such a quantity of cargo as can be carried at a speed of 19¼ knots.

From well-selected data Mr. Inglis then proceeds to compute the number of yearly voyages that can be made by a ship running at the last-named speed (deducting forty days for repairs), and the amount that she could earn on this basis, and, comparing these earnings with the earnings of vessels running at higher and lower speeds, he succeeds in showing that 19¼ knots is the speed affording maximum profit.

The diminution of profit at speeds higher than this is very rapid. Thus he shows that an increase of speed from 19¼ knots to 19.675 knots would wipe out all the profit. Reduction of stay in port from seven to four days would raise the speed corresponding to maximum profit to 20 knots.

These are only a few of the most important points made in this extremely able paper. The same method is applied to ships making longer voyages, one of the results arrived at being that a 12,000-mile voyage costs only 46 per cent. more than a 6,000-mile voyage.

The Pendulum Propeller.

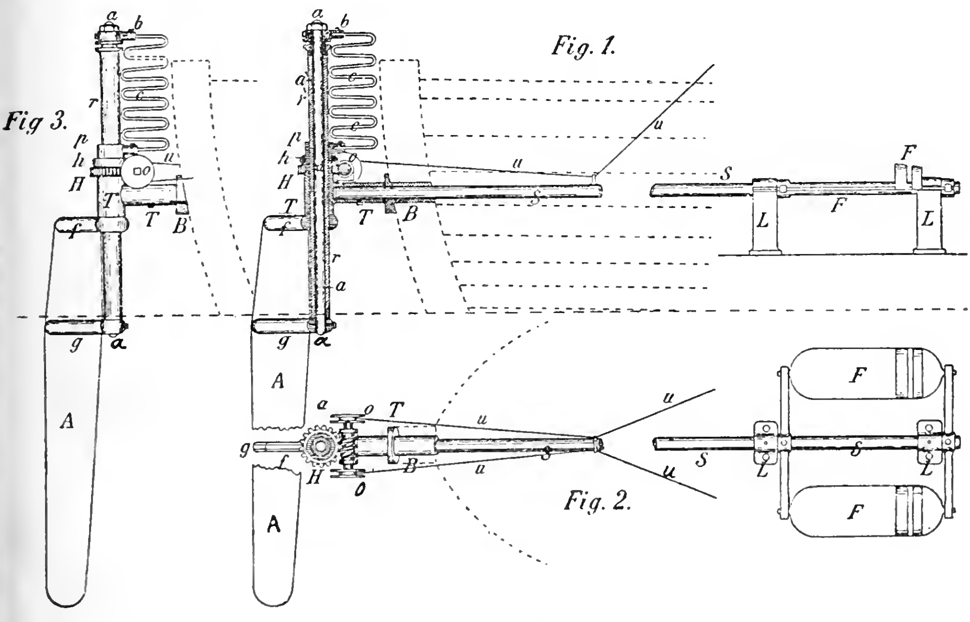
An exceedingly interesting paper upon this subject, by Mr. H. C. Vogt, of Copenhagen, is printed in *The Steamship* for January. The following abstract embodies the pith of this discussion, which results in the conclusion that this sort of propulsion, while superior to propulsion with oars (the latter being superior to the screw propeller for small boats), is only practicable for small vessels, or as an auxiliary propeller for small sailing vessels, say, up to 100 tons, for which, with an engine of 25 h. p. driven up to about 6 knots, it is superior to the usual propeller in every way.

Every observer of nature will doubtless acknowledge how far the devices of man in the domain of maritime propulsion are from the attainment of the results which, for instance, are obtained by swimming mammalia and fishes. It is said that a large fin-whale, with a displacement of about 30 tons, can swim at a speed of 50 knots an hour. In a case where one of these whales was harpooned from a cannon in a ship's bow, and the harpoon accidentally hooked itself fast in the cartilage of the back fin, without damaging the vital parts, the whale, by means of the strong chain fastened to the harpoon, drew a screw bark of 600 tons, with all sails set, against a fresh breeze, while at the same time its engine of 100 h. p. was backed with full power. It was said that this performance lasted for nearly two days at a speed of about 10 knots, after which the chain broke, and the animal went off at a tremendous speed. If the speed mentioned is correct, a power of 2,000 h. p., at least, was required for this performance. In the case of a smaller type, the dolphin, it is easier to obtain trustworthy information. From a fast steamer, running at a speed of 20 knots, it is often observed that the dolphin passes it with great ease, and its maximum speed is estimated to be 30 knots; while a Whitehead torpedo of about the same sectional area requires more than 30 h. p. for even a lower speed during a few minutes.

It is assumed, for good reasons, that the motion of a whale in swimming accords with that of a pendulum, and upon this assertion and other well-founded considerations a calculation of the horse power and speed of the fin-whale results in 1300 h. p. and a speed of 40 to 45 knots per hour.

The cut shows the construction and arrangement of the pendulum propeller as adapted to manual use. The want of adaptation of this system of propulsion to large vessels appears when the proper distribution of material, not much considered in the smaller propeller, is taken into account, and the question of higher speeds comes up. However, the simplicity of the machinery required and other advantages are thought to be sufficient to warrant further attention to the subject with reference to the propulsion of vessels within the limits named.

The propeller blade or rudder, *A*, is by the fork, *g*, firmly connected with the rudder stem, *a*, which, by means of the arm, *b*, and the spring, *c*, is connected with the cog-wheel, *H*, which, by means of the worm, *O*, can be turned round the tube, *r*, which also serves as a support for the rudder, *A*, the fork, *f*, rigidly secured on the rudder, *A*, being arranged to loosely embrace and turn on the tube, *r*. (The tube, *r*, also serves as bearings for the stem, *a*.) The piece, *T*, furnished with bearings for the worm, *O*, constitutes a rigid connection between the tube, *r*, and a horizontal main-shaft, *S*, which is provided with bearings, *L*, and a stuffing-box, *B*. On pulling one of the steering-lines, *u*, the worm, *O*, and consequently the cog-wheel, *H*, are rotated, and, by means of the spring, or springs, *c*, which connects the cog-wheel, *H*, with the rudder-post, *a*, the rudder, *A*, is turned. If, now, the main-shaft, *S* (Fig. 1), be put into an oscillating motion by the treadles, *F*, or by an engine (high pressure on one side and low pressure on the other), then the tube, *r*, with the rudder-stern, *a*, will swing like a pendulum in a plane at right angles to the plane of the drawing, and the pressure of the water on the rudder will cause it to oscillate about the axis of the post, *a*, first to one side and then to the other, in such a manner as to produce movements of the rudder similar to the strokes of the tail of a fish, by means of which the vessel will be propelled. Since the rudder-post, *a*, is connected by the spring, *c*, to the cog-wheel, *H*, which is fixed in position, the amplitude of the oscillation of the rudder, *A*, about the axis of the post is dependent on the strength of the spring, *c*. In the accompanying illustration only one spring, *c*, is shown, but any desired number of springs may be employed, according to the size of the rudder, these springs being all arranged between the cog-wheel, *H*, and arms, *b*, fixed on the rudder-post, *a*. The springs employed for connecting the wheel, *H*, with the rudder-post, *a*, may, of course, be of various forms and construction. It is absolutely necessary, for the sake of efficiency, that the entire area of the blade, *A*, shall be on one side of the produced axis through *a*. The rudder-blade, *A*, will thus swing harmonically round two axes,—namely, like a pendulum round the axis of the main shaft, *S*,—and at the same time (regulated by the spring *c*), it will swing round the axis of the rudder-post, *a*. By pulling one of the steering-lines, *u*, during propulsion simultaneously with the pendulum-like oscillation of the rudder, the rudder can be caused, while moving in one direction about the axis of the shaft, *S*, to make angle with a plane at right angles to *S* greater than that made by the rudder with the same plane when moving in the opposite direction, and thus to effect the steering of the vessel, while still producing in it a motion ahead or astern, as before. By pulling one of the steering-lines, *u*, until the rudder is turned through an angle of more than 90°, motion ahead can be converted into motion astern, and *vice versa*; and, by turning the rudder through slightly less or slightly more than this angle, the steering of the vessel may be simultaneously affected when going astern. In order that the particular working teeth of the wheel, *H*, may be changed from time to time to equalize their wear, the wheel, *H*, may be fitted on a sleeve, *P*, so that it can be turned on the sleeve and then refixed thereon by means of screws, *h*.



Repairing a Broken Thrust Shaft at Sea.

THE steamship, *Mara*, on a voyage from Demerara to Trinidad in the spring of 1895, broke her thrust shaft at the second ring from forward. The conditions of weather, etc., under which the accident occurred, and the temporary repairs of the shaft under most difficult circumstances, are the subject of an interesting and instructive narrative in *The Steamship* for March, of which we make the following abstract.

The ship was a cargo boat, and, like the majority of cargo boats, had not a superabundance of gear with which to cope with a break-down out of the ordinary run. The chief engineer knew this, and knew also that he would need a great many more tools than he had in repairing the shaft sufficiently to take the ship into the nearest port, which he had resolved to do. In the first attempt, the third watch was started on cutting out slots in the thrust rings on either side of the fracture, wide enough and deep enough to take short lengths of a steel crowbar, 1½ by 2 in., which was the first and best thing to hand, as it was necessary to get a few turns out of the engines as soon as possible, to enable the drifting ship to clear the end of the island, which was getting dangerously near. To cut these slots, drills and chisels had to be dressed and tempered. When the slots were cut, the bars were fitted in, and were kept in position by an iron clamp (taken from the derrick boom), which was a fit on the shaft, held by two 1⅜-in. steel bolts. Steam being raised, the engines were tried; after a number of revolutions, the steel bolts broke, and the clamp and bars were rendered unfit for further use. On the broken gear being cleared away, four slots were cut in the rings, and two more crowbars and a steel vice were cut up for bars. These were fitted into position, and the spaces were filled with wood to the outer edge of the rings; a strong chain was then happed round over all, and wedged tight. On starting the engines again, in which great care had to be used, the bars, etc., carried away without scarcely moving the after shafting, owing to the poor quality of the material of which the bars were made.

It was at once resolved to try another method of repair. The coupling guard was taken off aft, and the bolts driven out of coupling. The rivets in the tunnel top were driven out, and the plate removed. It was growing very hot in the tunnel, adding greatly to the discomfort of the men. Gear was rigged in the hold to lift out the after end of the thrust shaft. This was accomplished, and the shaft was placed on end, with the coupling down, on the tunnel floor, though at great risk to the men working there, as the ship was rolling about in the trough of the sea. A slot had to be cut through the shaft at the fracture, this, and to enable the two ends to be operated on at the same time, being the reasons for taking the shaft adrift. The tools for this operation, every one of them, had to be made on the spot. Four 1½-in. drills were made from an old slice, and were tempered so finely that they drilled through 10¾ inches of shaft without regrinding, with utterly inexperienced men working the ratchet.

The slots being cut, the after end of the shaft was dropped into its place, and coupled up. The slots, coming together, made a section 8 by 10¾ by ½ in., to fill up. The only available material of this size was the end of the propeller spanner, and this was cut up in 10¾-in. lengths. It was cut up red-hot, and the pieces formed the keys. The quality of the metal was none of the best, and there was a flaw running right through the center (which was not seen until afterwards), where there was the greatest necessity for soundness. The largest key was driven into the slot with the large hammer, it being a very good fit, and the shaft was lapped again with chain. To enable this to be done, the ring nearest the fracture had to be cut away. The engines were started gently, and were run at 35 revolutions per minute on 50 lbs. of steam. The ship was doing about four knots per hour.

After running about twelve hours, the key broke through the center, where the flaw was discovered. The pieces cut from the small end of the spanner were forged into shape and fitted into the slot, fore and aft, and steel wedges were made to take up any slack that might have been caused by the first key. When this was finished, the engines were got under weigh again, but were run faster this time, to allow the thrust on the shafting to do something towards keeping the keys tight. The ship was now doing about six knots per hour. The ship steamed into port seven days (lacking a few hours) after the shaft broke.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Marine and Engineering Journals—See Introductory.

4764. Inaccessible Maritime Lights. Elmer Laurence Corthell (Abstract of a paper promised in an early issue of Sci Am. Sup. Gives a well illustrated account of the unique system of electric lights used in the entrance to N. Y. harbor). Sci Am–March 14. 1500 w.

*4777. Repairing a Broken Thrust Shaft at Sea (An interesting and instructive narrative. Repairs accomplished under very difficult conditions). Steamship–March. 1200 w.

4779. New Orleans and Algiers Dry Dock (Particulars relating to the location of the new dry-dock, and the natural advantages which make it a judicious selection of site for the purpose of docking the United States war-ships of the larger size). Bradstreet's–March 14. 1200 w.

*4790. The Japanese Battle-Ship "Yashima" (General illustrated description. Details are promised in a future article. A plan and vertical section with dimensions are presented in this article). Engng–March 6. 2600 w.

*4792. The Belleville Boilers on H. M. S. "Sharpshooter." A. Dodgson (Brief description of the trials, tabulated data, and abstract of manœuvring trials). Engng–March 6. 400 w.

4894. Dry Docks in the Port of New York (Editorial. The position taken in the report of the board of consulting engineers to the effect that such docks should be a part of the dock system of New York is approved, and reasons for this view are given). Eng Rec–March 21. 800 w.

*4922. The Paddle Steamers Koningin Wilhelmina, Koningin Regentes, and Prins Hendrik (Illustrated detailed description of swift paddle steamers, built for the Zeeland Steamship Co., by the Fairfield Shipbuilding and Engineering Co., Limited, of Glasgow). Eng, Lond–March 13. 1300 w.

4972. The Danzenbaker Ice Boat (Illustrated description of a boat designed for breaking up ice obstructions to navigation on the Delaware river. The design contemplates the breaking up of the ice by a beak in the nature of a double mold-board plow, the point of which passes under the ice and whose inclined sides throw the broken ice away laterally in both directions). Shipbuilder–March 26. 900 w.

4973. Wells Engine in E. S. Renwick's Yacht (Illustrated description). Shipbuilder–March 26. 300 w.

4977. The Detroit Dry Dock Company's Plant (Brief but interesting illustrated description of a typical lake shipbuilding establishment). Sea–March 26. 1000 w.

4979. Triple-Expansion Engine of Yacht "Josephine" (Description with end elevation, side elevation and plan, showing all the principal features of the design). Am Mach–March 26. 300 w.

5035. The Naval Engineers' Reorganization Bill (Editorial review of the bill for reorganizing the Corps of U. S. Naval Engineers, introduced by Senator Squire and Representative Wilson. The main features of the bill are unqualifiedly approved). Eng Rec–March 28. 1800 w.

5086. P. A. B. Widener's New Steam Yacht Josephine (Illustrated description with side elevation and deck plans). Am Shipbuilder–April 2. 800 w.

*5176. Wreck Raising (Illustrated description of methods and appliances used by a leading English firm in salvage operations. The methods and appliances do not seem to differ greatly from those used in American waters). Engng–March 27. 4000 w.

*5177. Water-Tight Doors and Their Danger to Modern Fighting Ships. Charles Beresford (Paper read before the Institution of Naval Architects. Points out dangers attending present practice, and proposes remedies. These relate to the abolition of some of the water-tight doors, and the modification of others in respect to their size and their position in bulkheads). Engng–March 27. 3000 w.

*5178. Water-Tight Doors. N. Soliani (Paper read before the Institution of Naval Architects. Deals with dangers resulting from their use and suggests improvements in present methods. The danger is that such doors will be left open, and the reason they are so left is the difficulty in opening and shutting them. A method is proposed for the instantaneous opening or shutting of such doors by simply reversing an electric contact. Illustrated description of details is presented. Engng–March 27. 3000 w.

5215. Holland's Submarine Torpedo Boat (Illustrated description including a short biographical sketch of the inventor and designer—John P. Holland, of Newark, N. J.) Am Ship–April 9. 1800 w.

*5242. Engines and Boilers of the S. S. Aberdeen (Illustrated description). Eng, Lond–March 27. 700 w.

*5244. Water-Tube Boilers. J. Watt (Read at the 37th Session of the Inst. of Naval Architects. A study of defects in the type of boilers and of remedies for some of them, which are not inherent in the types, but result from faults in construction and setting). Eng, Lond–March 27. 2800 w.

*5257. Oil-in-Bulk Steamers (The advantages of shipping oil in bulk are in some measure neutralized by the difficulties met with in applying the method. These difficulties are explained, suggestions for possible improvement are presented). Eng's Gaz April. 1000 w.

Entrance Requirements, Endowments, and Scholarships at Cornell University.

IN our April number we reviewed an editorial (*American Machinist*, Feb. 13) which criticised the gradual increase of educational requirements for admission to technical schools, naming Cornell University as one of the American schools in which this tendency is most to be regretted. The opinion was expressed that the intention of its honored founder seems likely to be thus defeated. Some other statements not palatable to the faculty of that institution were made.

To this criticism Professor R. H. Thurston made a strong, but courteous, replication, addressed to the editor of the paper named, and printed April 5. We will quote a portion of this reply,—which fills about six columns,—and briefly outline the rest. After characterizing the remarks with reference to Cornell University as unjust, Dr. Thurston adds:

"It is said that Cornell University 'aspires to the position of a State university.' The fact is that this university was founded in compliance with a contract with the general government, on the part of the State of New York, by which the latter, accepting the terms of the land grant bill of 1862, bound itself to 'found a college' for the purposes of that grant. This was done, and Cornell University is the State university or college so founded. Its name was given it in recognition of the fact that Mr. Ezra Cornell gave a half-million of dollars to the university and supplied the site.

"It is said that its endowment consists largely of 'public funds.' The fact is that the $6,000,000 endowment of Cornell University includes but about $400,000 of public funds, and that these funds came originally, not from New York, but from the United States government. The income from this source is $20,000 a year; from other sources, a half-million.

"It is said that Cornell's ideas are not carried into effect. The fact is that Cornell made the motto of the university: 'I would found an institution in which any man can find instruction in any study'—meaning, of course, college, not elementary, work,—and this motto has appeared in every issue of the official register and catalogue of the university from his time to the present; and every year, thanks to private beneficence, not public funds, finds it more effectively carried into action. I doubt if any institution in the world comes so near his ideal as does the university founded by him. Certainly none of the older and greater universities of our country do; and such work as Cornell is doing for the people is not even attempted by any university of which I have knowledge abroad. The chairman of the German commission, visiting this country in 1893 to study methods in education, writes me that he and his colleagues are urging on the Prussian and German governments the adoption of original and valuable features of our work. Yet it is—and probably always will be—true that, with added facilities, much more may be done.

"The statement is made that Cornell 'does little more than duplicate facilities for education which exist in ample degree without it.' My own judgment is that this, though true in a degree of every reputable institution,—all being founded with a common purpose, education,—is less true of Cornell than of any other that I know. Cornell possesses in its $500,000 worth of technical equipment more of practically valuable and useful equipment for the work that Cornell was most interested in than, I think, any other college in the world; and I doubt if its courses or its outfits are duplicated or fully paralleled by any college or university in existence—and I am tolerably familiar with what is done on both sides the Atlantic and in and around the Pacific. We have students from all the grand divisions of the earth, who come to us because of our peculiar facilities in all departments of most importance to the people.

"It is asserted that 'the entrance examinations could not be better if they were intended to exclude students from the shops,' and that the founder's plans 'are forgotten.' This, of course, refers to the requirements, mainly, in our 'technical courses.' It is perfectly true, as we are proud—not to admit, but—to assert, that our entrance requirements to the regular courses in mechanical engineering, for example, are exceptionally—some of our friends think extraordinarily—high. They do not, however, exclude men from the shops; and we have, I am positive, many more men from the shops to-day than we had ten years ago, when the university and Sibley College assumed to teach elementary school work. The fact is that, given the right spirit, the young man in the shop will prepare himself for any course that is deemed by him to be likely to promote his ultimate success, even though he is compelled to study the higher mathematics; at least, that is our experience. Men from the shops still stand, with us, in many instances, at or near the head of the class."

Professor Thurston declares that the "high standard set for those who desire the diploma of the university" excludes no one "competent to do college work," and that want of social position closes no course of study to any applicant. Any one can at will choose and pursue any study for which he is found prepared. "Any deserving and ambitious young man may even enter the university, if twenty-one years of age, without an examination, if he can show any member of the faculty that he is of the right stripe, is ready to enter any work offered in the university, and can find enough to do to keep him busy fifteen hours a week at least. We have appointed hundreds of such men, and they often work their way up into regular courses, and finally graduate."

Without being able to fortify the impression by statistics, Dr. Thurston believes the number of shop-men in Cornell to be larger than it was ten years ago, and to be annually increasing. He asserts that "nowhere have the industrial classes a freer path," and that, "outside the courses leading to degrees, with its provision for special students, for optional courses," and for a great variety of courses of instruction, the university follows Cornell's motto in a manner that "commands the commendation and admiration of every intelligent man familiar with its work." That comparatively few take "elementary or half-way work" is the result of preference on the part of students themselves, and not of any restriction imposed by the institution. The summer schools afford facilities for the study of nearly all subjects that cannot properly be included in a college curriculum.

The existence of the aristocratic tendency among students, as charged by the *American Machinist*, is positively denied. It is asserted, on the contrary, that "there is nowhere illustrated a more perfectly democratic spirit." Cornell is declared to have been "maligned by those who should be its best friends. . . . Rich men's sons are welcome, and poor men's sons cordially received and cared for; but no one knows or cares which is which in the class-room or on the Campus."

Men who desire to help themselves financially are afforded opportunities in various ways for earning money. Among other excellent provisions for helping along poor students is the rule that "a desirable student is never turned away. His fees are omitted, if he is unable to pay." The number of those who are compelled to accept any of these provisions is small, as the majority of men are able to work their way through without such aid, and prefer to do so. Cases of men living on the merest pittance per week, yet retaining the respect of their fellow students, are instanced. In conclusion, it is asserted that all changes in the institution, since its organization, have been in the direction of more and better work, and of increased usefulness. That it has departed somewhat "from the humbler toward the higher field" is admitted; but this has been compelled by "State burdens changing circumstances, and excess of members seeking costly instruction."

The editor of *American Machinist* replies that the central idea in the editorial which called forth the defence of Cornell by Professor Thurston "was that scholastic admission-requirements had become so high as to shut out those who had not previously attended school without interruption." That readers may judge for themselves whether this view is or is not justified, it prints, as pertinent to the controversy, the requirements for admission to Cornell.

The Massachusetts Inspection and License Law.

How this law has operated during the past year, and the possibilities it opens for licensing incompetents should it remain in its present form, are editorially considered in *Lord's Magazine* for March.

This law requires that all boilers not periodically inspected by companies that have complied with all the laws of the commonwealth shall be reported to the State inspection department. This has given an impulse to the business of boiler inspection and insurance companies. Boiler owners seem generally to prefer to deal with such companies rather than with the State department. A general improvement in the condition of boilers has thus far resulted from the act. Such owners as have not dealt with the authorized inspection and insurance companies can be compelled by the State inspection department to use safer boilers, if the boilers they now use are pronounced dangerous by the State inspectors. Another good effect is the enforcement of better supervision for boilers used in schools and other public buildings for heating purposes only. How urgently such improvement was needed is illustrated by the following account of an occurrence in a school not specifically named.

"The janitor in the case noted was in the habit of leaving a good fire in the furnace on or before nine o'clock in the morning, and the steam pressure high enough to keep the rooms thoroughly warm until twelve o'clock, when he would give the boiler his attention again. One day, in the early part of the spring, the boiler was so left, and, the day turning out warmer than the janitor expected, the teachers in the building found it necessary to shut off the steam from the radiators. This naturally resulted in bottling up the steam in the boiler and main pipe, with no outlet for it. When the janitor returned, according to his usual custom, about twelve o'clock, he noticed a heavy pressure on the boiler. How high this pressure was he could not tell, as the gage was not large enough to register it. The safety-valve was also found stuck. Instead of reducing the pressure, as he should, the janitor pried the safety-valve from its seat with an iron rod. As a result, the steam rushed out, filling the cellar and the rest of the building with a tremendous roar, frightening the scholars so badly that they rushed from the building in a panic. Fortunately, none were seriously injured. Such a condition of affairs is not only possible, but decidedly probable, in any building where the boiler is so long neglected. The law has no provision, stating just how long an attendant shall be absent from the building; yet such length of absence is nothing short of neglect, and the janitor who is not in the habit of taking better care of his boilers would probably not be granted a license until he was found to be more competent."

So much with reference to boiler inspection. The license law has also been a means of great improvement, although it is shown to have grave defects. One of these is the want of provision for crediting an engineer for the number of years he has successfully operated a plant, making an examination necessary to qualification for a license to operate a similar plant. As the law stands, he can be licensed to run the same plant without examination, but not any other plant just like it, which is obviously absurd.

The system of classification has been much objected to also. As the law stands, 150 h. p. is the limit for second-class licenses, though no reason can be assigned why a man competent to run such an engine should not also be qualified to run a 500-h. p. engine. The following quotation will show the absurdity of a classification based upon the capacity of engines. "An engineer might be perfectly capable, from his experience, to handle 1000 h. p. of plain non-condensing engines in any plant, but be utterly at sea if placed in charge of a 125-h. p. plant with four valve engines or those of condensing type; just what grade of license such an engineer would be entitled to is a matter of conjecture."

It is further shown that the scheme of examinations is so devised that from the study of books alone candidates for licenses may fit themselves to pass and attain a first-class license without any practical experience whatever. The law also fails to specify not only the attention that should be given to boilers, but also that which should be given engines, the frequent lack of which is too well known. Engineers often absent themselves from their posts, and too frequently, when on the spot, neglect obvious duties. Some penalty should follow such neglect. On the whole, the law is approved, but the criticisms suggest lines upon which it could be amended to advantage.

The Thoroughfare Steam Jacket.

MR. W. H. BOOTH, a frequent and able contributor to the *American Machinist*, having challenged a statement previously made by Mr. Charles T. Porter (widely known in both America and Europe as one of the foremost engineers in the United States), the latter gentleman makes a courteous and instructive reply in the columns of the same paper (March 19).

Under the title above given, he first compliments Mr. Booth's ability as a writer upon a wide range of mechanical subjects, and then replies to the challenge of his statement that a body of steam more or less enveloping a cylinder, yet contained in space forming part of the channel for passage of steam from the boiler to the interior of the cylinder, is not a steam jacket. To a body of steam of this kind, as distinguished from what Mr. Porter would have no hesitation in calling a steam jacket, he now applies the expressive and convenient term "thoroughfare steam jackets," and, in reply to Mr. Booth, says:

"Mr. Booth has asked me to explain why I made the statement that 'the so-called jackets, through which the steam passes on its way to the cylinder, are not jackets at all.' This it will afford me pleasure to do, and I hope I may be able to do it in such a manner that Mr. Booth and all who may read the explanation shall be satisfied with it. The statement is, I admit, rather dogmatic in form, perhaps unnecessarily so, and to some it may on this account seem offensive. To such I beg to tender my apology for my apparent rudeness, but I expressed in fewest words exactly what I meant to say and am now ready to prove.

"But first I want to speak of the satisfaction with which I read Mr. Booth's remarks on the effect of air in the jacket, impairing and even ruining its efficiency. This subject was not mentioned in my article in the *American Machinist*, because that was a one-idea article, directed to an entirely different point. My view of the subject is, however, on record, as follows, on page 147 of the last volume of the Transactions of the American Society of Mechanical Engineers: 'I have long been impressed with the conviction that the efficiency of the steam jacket must be seriously impaired by the accumulation of air, which is abandoned by the steam as it is condensed, and which there is commonly no way to get rid of.'"

The method employed for ridding radiators of air—an air-valve at the point the farthest practicable from the point of admission—Mr. Porter regards as probably not adequate for a steam jacket. Of a design for a vertical tandem compound engine, shown and described by him in the paper above referred to, and which engine is now being constructed in triple-expansion form, he says:

"I have provided a current through the cylinder heads and through every part of the jackets, into a reheater, in which the air is finally separated and discharged. I rely on this current for carrying with it all the air, on account of its sweeping nature and its downward direction. The cylinder heads, by the way, I regard as forming the most useful part of the jacket.

"I cheerfully admit that, of all means

for freeing a jacket from air, a current of steam sweeping through on its way to the cylinder must be the most effective. The jacket, however, as everyone will agree, is not made for the purpose of being kept free of air. Its office is to reduce to a minimum, and, if possible, to prevent altogether, the condensation of the steam as it enters the cylinder. We seek to get rid of air only because it interferes with the performance of this function.

"Any argument on this subject must assume the steam to arrive at the cylinder entirely dry. It is obviously absurd to expect the jacket to prevent, or even to diminish materially, initial cylinder condensation, when the steam brings water with it to chill the internal surfaces by its evaporation during the exhaust. This chill extends to the jacket, causing the steam in it to be condensed to no purpose. In cases of wet steam, the plan of Hick, Hargreaves & Co., described by Mr. Booth, of diverting the jacket from its legitimate use to serve as a separator, seems a very good one. The chamber inclosing the cylinder is made to answer some purpose, instead of being quite useless—only it should be called by its right name. The fact that boilers do commonly deliver more or less water with the steam does not affect the question. Dry steam is the fundamental requisite for economy, and, moreover, it can always be had. It must be assumed in any discussion of the action of the jacket.

"In every steam engine, superheating being left out of the account, at each stroke of the piston water must appear somewhere. Work is done. An equivalent number of units of heat disappear. These are supplied by the steam. A portion of it has lost its heat of vaporization. At the end of each stroke the water thus formed is either in the cylinder or in the jacket, —most commonly partly in each. That in the jacket is under the boiler pressure and has the boiler temperature, and can be returned to the boiler to have its heat of vaporization restored. That in the cylinder is thrown away with the exhaust, and this is not the worst of it. This water also has its heat of vaporization restored, and the cylinder does it. All the internal surfaces of cylinder, heads, piston, passages, and valves are chilled to the extent necessary to effect the re-evaporation of this water during the exhaust. At the moment of the next admission these surfaces are dry and cold. The first work of the entering steam is to heat them up again, for they must have the full boiler temperature, or the pressure cannot be in the cylinder. This the steam does by condensing in a dew all over them, and now at the end of the stroke there is twice as much water in the cylinder to be evaporated. The sole function of the jacket is to prevent this cylinder condensation, which must follow the evaporation during the exhaust.

"Now, the so called jackets, through which the steam passes on its way to the cylinder, perform another function besides freeing themselves of air; they condense a portion of the entering steam, and sweep that along into the cylinder, to be evaporated precisely as if it had come from the boiler, thus defeating entirely the object of the jacket. This form of jacket was, so far as I know, first used in this country by Mr. Corliss, after he introduced his vertical boiler, which superheats the steam considerably. Copying him, some makers of his engines, as well as others, now use this construction—without employing superheated steam."

Topical Discussions.

TOPICAL discussions in engineering societies form one of their most valuable features. There is nothing that elucidates engineering subjects more than the free expression of opinion, wherein the results of practical experience and theoretical considerations have equal place. The interest and importance of such discussions is more and more recognized as time advances, and many societies now pre-arrange for the discussion of topics announced in advance of regular meetings. This organizes such debates into a system, and renders them exceedingly effective. It increases the attendance at meetings, and maintains a vital interest in the proceedings of the societies.

Conspicuous among the societies which have promoted topical discussions is the Western Society of Engineers, which has commenced the regular issue of a well-edited bi-monthly journal. As a sample of the thoroughness with which this sort of work is conducted in this society, the following excerpts are made from its March circular to members and others.

"The subject selected is that of 'Steel Forgings.' All discussions sent to the society will be carefully edited and published in the *Journal*. We enclose herewith a list of questions which have been prepared in regard to 'Steel Forgings.' We will appreciate very much receiving from you a discussion on this subject. The questions are submitted to you merely as suggestions. We wish to obtain for publication the fullest and most practical information possible. Your discussion should be in the hands of the committee not later than April 30. Will you kindly favor us with such information as you can on this subject? The discussion, when published, will be sent to all persons who contribute any material. We are promised a very full discussion from a number of manufacturers and engineers who are in possession of valuable information.

"(1) Are there any advantages of steel over wrought-iron forgings? If so, what are they? (2) Are forgings made from open-hearth steel superior to those made from bessemer steel? If so, why? (3) Is there any difference, for practical uses, between forgings made from basic and acid steel? (4) What methods have been found to give most satisfactory results in producing solid and homogeneous ingots from which forgings are to be made? (5) Should steel forgings be made under separate and distinct methods of treatment from wrought-iron forgings? (6) What are the relative merits of hammered forgings and those forged under press? (7) Should there be any treatment of forgings subsequent to forging and before machining? If so, what? (8) What is the effect of simple annealing of forgings, and also of tempering and subsequent annealings? (9) What is the best form of specification for drop-hammer rods, stamp stems, and other similar forgings which are subjected to shock and vibrations?"

The field covered by these questions is one of broad interest to all who use iron and steel as materials for manufacture; and, if the subject be as ably handled by participants in the discussion as was the subject of hydraulic cements in the meetings of this society, we may anticipate much interesting information to result.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

The Machine Shop.

*4731. Modern Machine-Shop Economics. Horace L. Arnold (Pointing out the considerations that should govern shop locations). Eng Mag-April. 3700 w.

4750. The Sand Blast Apparatus for Cleaning Castings. Fred C. Brooksbank (An interesting paper setting forth at length the uses of the sand blast in the treatment of castings, its advantages as compared with pickling, some of the disadvantages of pickling, and other matter of interest to iron founders). Ir Age-March 12. 5000 w.

4753. Making Large Brass Castings. C. Vickers (Practical hints upon the subject). Am Mach-March 12. 900 w.

4914. Making a Large Kettle in Loam (Illustrates and describes the molding and casting of kettles weighing 18000 lbs., several of which have recently been produced in a western iron foundry. A good study in loam practice). Foundry-March. 700 w.

4918. The Foundry Foreman. H. R. Ramp (A plea for higher salaries for competent foremen, in the interest of foundry owners). Foundry-March. 800 w.

4939. Sheave Wheel with Wrought Iron Arms. W. H. Osborn (Illustrated description of the moulding and casting of sheave wheels with wrought iron arms and of diameters ten feet and upwards). Ir Tr Rev-March 19. 700 w.

4978. Electric Welding in England. John Marsden (Letter reprinted from the *Mechanical World* (England) presenting an interesting account of electric welding as practiced in a shop doing a wide variety of machine forging and repairing). Am Mach-March 26. 1000 w.

*5044. Electric Power Transmission in Workshops. Daniel Adamson (The bulk of this paper is devoted to a description of, and remarks upon applications of electric power in a large workshop in England. Though thus restricted, useful hints upon such applications are presented). Prac Eng–March 20. 3000 w.

5066. Cleaning Castings by Hydrofluoric Acid. R. Moldenke (Hydrofluoric acid is recommended as a substitute for sulphuric acid as a pickle for castings, and its superior advantages are set forth. It actively dissolves the silica in the scale, and only attacks the iron in strong pickles). Age of St–March 28. 1800 w.

5069. A Few of the Snares of Pattern Making. John M. Richardson (A plain practical discussion. Hints towards the avoidance of mistakes in pattern shop and foundry). Mach–April. 1800 w

5216. Lathe for Boring and Turning Sixteen-Inch Guns at Watervliet Arsenal (Illustrated detailed description of a lathe weighing 280 tons, 138 ft. long, whose head stock alone weighs 52 tons, and each carriage 18 tons. The 16-in. guns turned in this lathe weigh 142.5 tons and are 50 ft. long). Am Mach–April 9. 5400 w.

5217. The Practice of the Ordnance Department, U. S. A., in Doing Lathe Work on Heavy Guns. Anthony Victorin (Illustrated detailed description). Am Mach–April 9. 5200 w.

Steam Engineering.

4752. Water-Hammer in a Steam Pipe—The Cause and Its Cure. William J. Williams (Account of the rupture of an iron body stop valve in a 3-inch wrought iron pipe, and of a case of severe water-hammering cured by a simple change in the boiler connection of the steam-pipe. Sketches illustrate the wrong way and the right way). Am Mach–March 12. 800 w.

4820. Water Purification for Steam. John M'Naull Wilson (Read before the Northwestern Electrical Assn. Recommending the purification of water outside of the boiler, in tanks, whereby all scale forming solids are precipitated and soft, clean water only supplied to the boiler). Elec Rev–March 18. 3800 w.

4861. Superheating. W. H. Booth (A historical, theoretical, and practical paper). Am Mach–March 19. 1600 w.

4863. The Thoroughfare Steam Jacket. Charles T. Porter (Reply to a criticism by Mr. W. H. Booth of views previously expressed by the author, relating to the advantages of steam jacketing). Am Mach–March 19. 1100 w.

4865. Impossible Guarantees (A cause of great annoyance connected with the operation of steam plants is discussed). Eng Rec–March 14. 1000 w.

4871. The Corliss High-Service Low-Duty Pumping Engine of the Providence Water-Works (Illustrated description of an engine of novel and peculiar design, built for pumping directly into high-service mains). Eng Rec–March 14. 200 w.

*5052. Determination of the Moisture in Steam. R. C. Carpenter (This paper points out errors likely to be made in the use of calorimeters, and endeavors to show that if proper allowances be made for losses, correct results in the determination of moisture in steam may be obtained by the calorimetric method). Sib Jour of Engng–March. 4000 w.

*5107. Angular Advance. O. H. R. (A critique on a method often employed in explanation of the meaning and effect of angular advance in cases where link-motion reversing gear is used. A correction of the method is proposed and explained). Loc Engng–April. 1200 w.

5119. Cooling Water for Condensing Purposes. W. H. Booth (Description of various methods of cooling water for repeated use, in condensing exhaust steam, with illustrated description of an evaporation condenser). Am Mach–April 2. 1200 w.

5121. Latent Heat (Editorial. Starting with the assertion that the term "latent heat" is very inadequately comprehended, this article, in the form of a reply to a correspondent, gives an explanation of the term, and the relation of latent heat to sensible heat). Am Mach–April 2. 1600 w.

5125. The Strength of Boiler Flues (A summary of the results of tests made at the Imperial Docks at Danzig in the six years from 1887 to 1892. A very thorough and important study). R R Gaz–April 3. 2000 w.

†5168. Experimental Determination of the Influence of Back Pressure on the Economy of a Surface Condensing Engine with Independent Vacuum Pump. Percy Allan, Everett Bruen, Frederick K. Vreeland (Illustrated description of apparatus and method and an account of test, with diagrams and tabulated data). Stevens In–April. 6000 w.

*5187. The Economics of Propulsion in the Modern Steamship. R. L. Weighton (Lecture delivered at the Marine Engineers' Institute, South Shields, on the 9th of Dec. 1895). Prac Eng–March 27. Serial. 1st part. 3000 w.

5222. Fly-Wheel Governors. George T. Hanchett (Fly-wheel governors and some of the principles of their design). Elect Wld–April 11. 1600 w.

Miscellany.

*4730. The Present Status of Aerial Navigation. Ill. Octave Chanute (Showing the progress made in aerial navigation during the last four years, and the comparative importance of studying the flight of the sailing birds rather than that of the flapping birds). Eng Mag–April. 3200 w.

4754. Rope-Driving Practice. W. H. Booth (Hints derived from English practice. Discusses the superiority of cotton for power transmitting ropes). Am Mach–March 12. 1500 w.

4823. The Limits and Possibilities of the Gas Engine. Sidney A. Reeve (A critique on Mr. George Richmond's article on the same subject published in *Engineering Magazine* for Feb. Mr. Reeve, while conceding the value and interest of Mr. Richmond's paper, yet joins issue with him in several points). Pro Age–March 16. 3700 w.

4824. The Measurement of Cyclically Varying Temperature. Henry F. W. Burstall (This paper embodies results of attempts at measuring temperatures reached in the cylinder of a gas engine in progress since 1892. A very important paper, with numerous diagrams and tables). Pro Age–March 16. 4500 w.

*4837 The Storage and Explosion of Compressed Gaseous Mixtures (Report of committee of British Board of Trade appointed to inquire into causes of this class of explosions and precautions necessary to be adopted). Jour Gas Lgt–March 10. 2200 w.

*4838. Researches on the Combustion of Illuminating Gas in Cooled Flames and Gas Motors. Dr. F. Haber and A. Weber (Account of researches carried out in the Chemical Tech. Inst., at Carlsruhe, at the instance of Dr. H. Bunte). Jour Gas Lgt–March 10. Serial. 1st part. 2800 w.

4856. The Explosion in the Oil Engine. Samuel Rodman, Jr. (A critique of views previously published in the same journal by Mr. Tecumseh Swift). Am Mach–March 19. 900 w.

4857. The Method of Projection That Is Actually Used. Louis Rouillion (Results of inquiries made by a committee of the Art Teachers' Assn. Letters of inquiry were addressed to technical schools, teachers, colleges, authors, and leading mechanical firms. The third angle method of projection is recommended as the simplest and most used). Am Mach–March 19. 1000 w.

4858. Measuring a Steel Tape. Walter Gribben (A good illustrated description of a job quite out of the usual run of machine shop work). Am Mach–March 19. 1000 w.

4888. Fittings and Joints for High Pressure Piping. John Platt (Discusses various methods of making tight joints in pipes with illustrated descriptions of joints which have proved eminently serviceable and durable; also presents a table of proposed standard flanges for hydraulic packing for the adoption of which an effort is now being made). Eng News–March 19. 1100 w.

*4908. Mechanical Connections. Francis B. Crocker (The following connections are considered: chain and sprocket wheel; magnetic belting; shafting; shaft couplings; friction clutches; magnetic clutches; pulleys; toothed friction; and other gearing). Elec Pow–March 1. 4800 w.

4915. Manipulation and Deterioration of Cast Iron. H. J. Grof (Characteristics of cast iron, and the scientific and frugal principles of melting it in cupolas). Foundry–March. 1200 w.

4916. The Mobility of Molecules of Cast Iron. Alexander E. Outerbridge, Jr. (An exceedingly interesting paper, in which the general belief that repeated shocks make cast iron brittle is disproved by results of about 1000 tests, showing that within certain limits cast iron is strengthened by subjection to shocks). Foundry–March. 2800 w.

4917. How Can a Founder Determine the Value of New Devices and Fluxes which Are Recommended to Him (A plea for systematic testing of foundry materials and appliances). Foundry–March. 900 w.

*4921. Mechanical Engineers' Estimating (Changed conditions have rendered new and more elaborate methods necessary. These methods are editorially considered). Eng, Lond–March 13. 1800 w.

*4927. Official Report on the American Horseless Carriage Trials (Complete text of the report of the judges of the competitive trials at Chicago). Eng, Lond–March 13. 7000 w.

4980. The Tests of Motocycles at Chicago (Summary of a report of a committee of examination, with tabulated data). Am Mach–March 26. 550 w.

*5027. Automatic Firing Guns. Hiram Stevens Maxim (The first part is devoted entirely to the history of revolving fire-arms). Ind & Ir–March 20. Serial. 1st part. 2200 w.

*5051. A New Method of Governing Water Wheels. Harvey D. Williams (Illustrated description of a new method whereby the speed is corrected by energy that would otherwise be wasted because of incorrect speed). Sibley Jour of Engng–March. 2000 w.

†5062. Automobile Vehicles. Pedro G. Salom, with discussion (After a brief historical retrospect, the bulk of the paper is devoted to a description of the Morris and Salom Electrobat). Jour Fr Inst–April. 6800 w.

5067. Some Early Milling Machines (Historical notes relating to the first beginnings of milling machine construction). Mach–April. 1500 w.

†5082. A Study of the Causes Which Lead to Breakage of Gears and Pinions. Charles F. Uebelacker (The first part deals with the gearing of electric motors on street cars, in which the conditions are severe. Diagrams and formulæ are presented, but the discussion is in the main practical in character). St Ry Jour–April. Serial. 1st part. 1800 w.

5088. Niagara Falls Hydraulic Power Plant (Interesting illustrated description). Sci Am–April 4. 1600 w.

5118. A Stone Planer (Illustrated detailed description of construction and operation). Am Mach–April 2. 1000 w.

5120. Power Calculation for a Traveling Crane. Charles I. Griffin (Formula for computing is presented, based on the principle that the power required for bridge traverse will be practically that required to overcome journal friction after the speed has once been established. The power necessary for starting is separately dealt with, as is also the power for effecting the hoist). Am Mach–April 2. 1300 w.

5148. Artificial Refrigeration. George Richmond (A popular lecture delivered at Cooper Inst., March 1, 1896, under the auspices of the N. A. S. E. Power–April. 4500 w.

5151. Compressed Air. W. L. Saunders (The subject will be treated under three heads,—production,—transmission,—and use. The first number treats of the relation between heat produced in the act of compression and the mechanical energy expended in the act). Compressed Air–March. Serial. 1st part. 1700 w.

5224. The Gas Engine and Its Electric Applications. Charles Macdonald (Read before the Chicago Electrical Assn. A brief review of the history and development of the gas engine of the past and present). Elec–April 8. 4500 w.

MINING & METALLURGY

The Walrand-Legenisel Process.

In a paper read before the American Institute of Mining Engineers (Pittsburg meeting), Mr. H. L. Hollis describes this interesting modification of bessemer practice, along with the later improvements in continental works. *The Iron Age* (Mar. 5) abstracts as follows:

"Briefly stated, the Walrand-Legenisel process is an addition to the bessemer operation, with the object of obtaining quiet and more fluid steel and consequently sound castings and ingots. This is achieved by adding ferrosilicon at approximately the time of flame-drop in the ordinary bessemer operation and making an after blow. The high calorific power of silicon is well known, and the rapid combustion of it immediately before pouring raises the temperature of the steel most noticeably, and what is further, finishes the steel-making operation by the combustion of silicon to a solid (slag) instead of carbon to a gas. The high temperature thus obtained and the consequent fluidity of the steel is well shown by the very small and intricate castings, running down to a fraction of a pound in weight, which are regularly made; but perhaps the best indication of the heat of the steel is shown by the fact that as small charges as six hundred pounds have been blown successfully for several years at Paris, and often the charge poured entirely into small work, taking from fifteen to twenty-five minutes, without a sign of skull in the ladles.

"The details of practice vary considerably at the different works where this process is employed, but the features in common are briefly these: the vessels employed are the usual type of bottom-blown bessemer converters. These receive the pig iron in the ordinary way, and the blowing is continued until about the time of flame-drop, when the vessel is turned down and ferrosilicon (containing from ten to twelve per cent. silicon) is added. An afterblow is then made, the time for terminating which varies at the different works. After this, ferromanganese, or spiegel, is added to the vessel for recarbonizing, and the steel poured into large ladles on cranes or small hand-ladles, according to the nature of the work. The blowing is generally controlled by aid of the spectroscope.

"A mention of the differences in practice may be of interest. At the works of Eugene Legenisel in Paris there are two converters, one of 1200 pounds' and one of 600 pounds' capacity. The sprues and heads and all steel scrap are melted with the pig iron in the cupola, and every cupola charge consists, after the first one or two heats, of about 80 per cent. pig and 20 per cent. steel scrap. The ferrosilicon and spiegel additions are melted in small and very ingeniously arranged cupolas and added to the converter by means of ladles. In blowing the converter is turned down the first time just short of flame-drop, so as to leave enough carbon to act as an index in the spectrum of the afterblow. The silicon in the steel very seldom exceeds 0.05 per cent., and often runs down as low as 0.02 per cent. A very large part of the small work is cast in green sand. At the works of the Messrs. Schneider, Le Creuzot, there is one 1,500-pound converter. The steel scrap is added directly to the converter, and the ferrosilicon and ferromanganese heated red, but not molten. The spectroscope is used to control the blowing, as at Paris, but the vessel is turned down younger in the afterblow, and the aim is to have 0.20 per cent. silicon in the steel. At the works at Hagen, Westphalia, there are two 1,200-pound converters. The blowing here is continued to flame-drop for the first turning down, and the afterblow regulated more by time and the general appearance of the flame than by the spectroscope. The additions are melted in crucibles, and the small work is poured from crucibles. The Potter & Hollis Foundry Company, Chicago, have had for several months one 1,500-pound converter in operation, and another one is now being added. The steel scrap is added entirely to the cupola mixture, and the ferrosilicon and spiegel added molten. The blowing is controlled practically the same as at Paris. The most important change in practice is in the blast pressure. On the continent very high pressures are employed,—up to thirty pounds per square inch,—while at Chicago not over ten pounds has been used. Melting the additions in crucibles, as at Hagen, and in small cupolas, as at Paris, has been tried, and the former certainly is more satisfactory. The pin bottom, as used at Hagen, and also the usual tuyere bottom, have been tried, and it is, perhaps, too early to say which gives the better results. The steel made by this process is satisfactory in every respect. Entirely sound castings of any size, up to the capacity of the vessel, as well as ingots, are obtained, and the steel shows high physical tests.

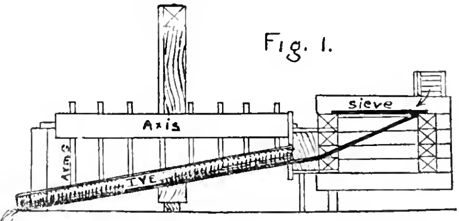
"A word in regard to the silicon in this steel. While it is possible to run the silicon down for regular practice as low as 0.05 per cent., it is found that nothing is gained by doing this, so far as castings are concerned. By increasing the silicon (even as high as 0.50 per cent.) the tensile strength is raised very much without appreciably lowering the elongation. Tests for magnetic permeability have been made with this steel containing over 0.30 per cent. carbon and with manganese above 1 per cent., which have given the very best results. While it is not the intention of the writer to theorize, it would seem that the very high casting temperature, together with the freedom from gas, resulted in physical conditions in the steel which modified the influence of the chemical constituents, as generally formulated."

Gold Mining in Russia.

GOLD occurs both in quartz and in alluvial deposits. The former were treated with little profit when the attempt was made as far back as 1779, but the former were worked to the extent of about a ton of gold per year. The methods of concentration, according to *Machinery* (London, March 15), are on the principle of the old-fashioned tom. The simpler form consists of a series of two troughs fourteen feet long and eighteen inches wide, one emptying into the other. The rich sands are thrown into the upper one under a stream of water, and raked and stirred, the coarse pebbles being retained by a perforated plate at the end and the fine material running into the second trough. This is provided with cross slats on the bottom, which catches the mud and through which the gold sinks and is thus retained. There are, however, two more complicated forms employed, illustrated in Fig. 1 and Fig. 2. The first is thus described :

"The kind in common use is figured in our illustration, which, in operating, will give employment to about eight men. The sieve, or grating, firmly fixed, is 3½ feet square. The tye with which the fine sand is carried by an inclined plane is 16 feet long by 2½ feet wide, with an inclination

Fig. 1.



varying according to the nature of the sand, and having its bottom curved in the arc of a circle.

"Above the tye is a wooden axis, turning in gudgeons, and having fixed to it beneath as many arms as the tye has compartments, each of which is fitted with a number of claws or blunt knives, and by an alternating motion, given to the axis by two men holding a line attached to it, the claws pass backward and forward in an arc, and keep the sediment in continual agitation. The partitions in the bottom are ribs, 2 inches high and 2½ inches wide, held by screw bolts and nuts, and can be removed at intervals for washing out the concentrated auriferous sand, the more frequently as the sands are richer in gold. This has been more fully described by the great authority on gold mining, Mr. Warington Smyth.

"Another Russian gold-washing apparatus is that shown by Fig. 2. This may be familiar to the few who know the district, but it cannot fail to interest all who are in any way connected practically or otherwise in search of the precious metal. This machine has been commented upon favorably by Captain Razguildeyew. To make our illustrations clear the description is as follows: A is an upper ring, across which are suspended the iron harrows, a; it performs a rotary motion by means of the two lever arms, g and h, on the tramway, n, o. b is the grinding floor or sieve, which is slightly concave in the centre, and is formed of plates of cast-iron joined together. c is the lower stage of the machinery, on which the disintegrated sand can fall from the sieve; then the sand, borne by water, falls on the washing

apparatus will wash 10,000 puds—cf 36 pounds—in twenty-four hours, and requires about six horses.

"The purest gold which is found in a native state always contains a percentage of silver, sometimes in such proportions as to change the appearance of the mass, making it white instead of yellow. Gold is found in combination with copper, and by this admixture proves that gold, whether in quartz or in alluvial deposits, was so placed by precipitation or evaporation from solution. In the auriferous sands of the Urals—which, though called sandy, are but very slightly sandy clays—platinum generally accompanies the gold. This is not often met with otherwise than with this metal."

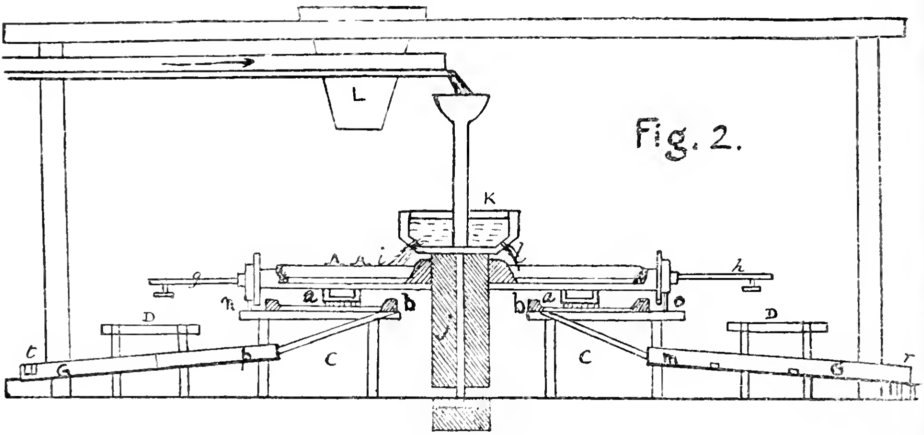


Fig. 2.

tables, m, n, o, p, which affect the concentration of the auriferous matters. q, r, s, t are reservoirs for the dirty water and sand. From these the sands are finally thrown away or rewashed on a table. D is the horsewalk, e the opening for exit of pebbles or gravel not shown, f table for washing pebbles—which is usually placed under the sieve. The water from this table passes over another one shown at G, on which finally the minutest particles of gold are deposited. K is the general receptacle or box of cast iron fixed to the iron spindle, j; the water from this reservoir is spread by the iron pipes, i, l, arranged so as to wet the sands. This same water passes over the washing tables, and thence into the settling reservoirs. L is the sludge channel for the sands. This

Hydraulic mining has been found impracticable. Quartz veins are worked which contain eight pennyweights of gold to the ton; the ore is crushed, and then treated as in the case of alluvial deposits.

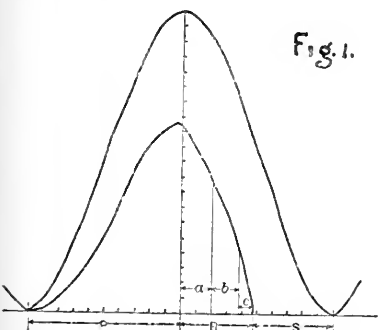
The Cycle of the Plunger Jig.

THE author of this paper, Prof. R. H. Richards, contributed to the American Institute of Mining Engineers (Pittsburg meeting) a very valuable addition to their proceedings when he gave them the results of his experiments in this little-understood field. After describing the apparatus by means of which he secured the curves representing the movement of the water, tailings, and ore, and giving the diagrams and tabulated results, he says:

"It will be seen, upon inspection of the diagrams, that the water-curve, W, and the quartz curve, R, rise to their highest points and then descend, but that the quartz always gets down before the water. We may say that there are three periods: (1) pulsion; (2) return; and (3) repose, or suction.

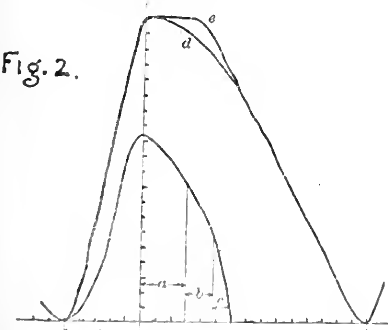
"To aid in this discussion, two ideal diagrams (Figs. 1 and 2) have been drawn. In Fig. 2 two top curves are given; the flat top, *e*, and the pointed top, *d*. A few of the diagrams indicate that the flat top

Fig. 1.



PLAIN HARZ ECCENTRIC JIG.
Ideal Diagram.

Fig. 2.



ACCELERATED JIG.
Ideal Diagram.

is normal; but the remaining accelerated-jig curves speak for the pointed top.

"The three periods named may be further discussed as follows:

"Period I.—Pulsion, P, or upward movement. The water- and quartz-curves diverge, because the water is moving up faster than the quartz. Here the law of hindered settling is acting to bring the coarse galena below the quartz, and the fine galena adjacent to, and in equilibrium with, the proper size of quartz.

"Period II.—Return downwards, R, which is divided into three periods:

"(*a*) A moment when the quartz- and water curves are converging, because the water is moving down faster than the quartz. Here the fine grains of galena acquire their maximum velocity downwards before the coarse grains of quartz; and hence Rittinger's law of acceleration is probably at work, helping the fine galena to get below the coarse quartz.

"(*b*) A moment when the two lines of quartz and water are parallel,—that is, a moment of relative idleness as to separation.

"(*c*) A moment when the curves of quartz and water are diverging. The sand is falling faster than the water; hence the law of hindered settling is again at work.

"Period III.—Suction, S. Here the sand reposes upon the sieve. The water-curve, W, is converging rapidly towards the horizontal quartz-line, R; therefore, the water is passing down through the sand at a high rate of speed. Here suction comes in to draw downwards through the interstices the small particles of galena which the law of hindered-settling has placed adjacent to, and in equilibrium with, the larger particles of quartz.

"Looking at the jigs by classes, we see that the eccentric jigs invariably spend more time upon pulsion than the accelerated jigs. Is it not fair to conclude that the eccentric jigs are better adapted for treating sands which require the most pulsion? Such sands are the sized products from the trommel and the first spigot of the hydraulic classifier.

"On the other hand, may not the long-protracted mild suction of the accelerated jig be the best adapted to the treatment of such products as required primarily suction for their separation,—for example, the second spigot and following spigots of the hydraulic classifier?

"The two extreme suggestions arising from a contemplation of these curves are:

"1. That on closely-sized products an accelerated jig should be used, run *backwards*, to lengthen out the pulsion-period, which is the only period that does any work; and

"2. That the accelerated jig should be run *forward* on the spigot-products of the hydraulic separator, to increase the period of suction.

"There are in the way of the first suggestion two difficulties, either of which may cancel the advantage: first, the violent downward motion of the quick return will tend to 'blind up' the sieve; and secondly, the same action will tend to pulverize a soft mineral like galena.

"I am not ignorant of the wide difference between theoretical speculation and commercial operation, in which it often happens that some small, unnoticed need of practice undoes a beautiful theory, rendering it unsuited for adoption. The suggestions offered in this paper are therefore put forward simply as ideas which appear to have merit and to be worthy of further study and test."

Balance-Sheet of a South African Mine.

We take this abstract from the *Mining and Scientific Press* (Jan. 11) for the valuable data it contains relating to interesting mines:

"The following is the official report of the directors of the Wemmer mine at Johannesburg, South Africa, for the month of October. The Wemmer is what is called a 'main reef mine'; its capital is £55,000; its market value, £550,000; it is six years in existence; its present monthly profit is about £11,000. The figures below are of interest to the American miner:

EXPENDITURE.

		£	s.	d.
Mining account.		£5,725	1	6
Sorting account.	£495 12 11			
Less stone sold.	188 5 6			
		307	7	5
Water service from pan to mine		5	6	3
Total......	10,985 tons....	6,037	15	2
Reduction expenses—				
Crushing ore..	1,158 3 5			
Concentration.	230 10 6			
Tailings wheel.	14 4 11			
Electric lighting.........	33 4 11			
Breaking rock at main shaft.	126 5 7			
Transportation of ore to mill.	217 10 9			
Total........	7,052 tons.....	1,780	0	1
General charges—Licenses, medical expenses, directors' fees, sanitary expenses, accident and fire insurance, salaries and charges......	7,052 tons	£ 413	12	0
Development redemption...	7,052 "...	2,467	10	0
Cyanid works—Treating	4,375 "...	765	3	6
Total expenditure...........		11,464	1	3
Profit for month...		11,057	12	10
Grand total.................		22,521	14	1

REVENUE.

		£	s.	d.
Gold account—				
4098.63 ounces bullion realized.		14,954	6	1
Cyanid works—1,585 05 ounces bullion realized............		5,433	11	4
Concentrates estimated for October production......	2,499 0 0			
Less deficit on September production....	365 3 4			
		2,133	16	9
Total income...............		22,521	14	1
Total amount spent on development, including 423 feet of driving and sinking........		1,933	4	5

CAPITAL ACCOUNT.

	£	s.	d.
New incline main shaft.........	375	15	6
Buildings and general improvements...	1,062	1	0
Total cost of improvements.	1,437	16	6

MILLING RESULT FOR OCTOBER.

Stamps at work...............	50 stamps.
Working time..	30 days.
Tons crushed..................	7,052 tons.
Tons crushed per head per day....	4.70 tons.
Bar gold extracted	4,098.63 ozs.
Yield per ton crushed...........	11.62 dwts.
Tailings treated...............	4,375 tons.
Bullion returned......	1,585.05 ozs.
Concentrates caught.....	160 tons.
Assay value....................	5 ozs. 6 dwts.

"The total yield per ton, including extraction from tailings and concentrates, is 18.78 dwts. fine gold."

Oregon Nickel Deposits.

In a paper recently read before the Colorado Scientific Society Mr. W. L. Austin describes the nickel veins near Riddle's, Josephine county, Oregon. These are noteworthy as being the only deposits of nickel ore in the United States, so far as known, with the exception of the Nevada occurrences, which appear to be of commercial importance, and which are now of special interest in view of the demand for nickel steel for armor and other uses. The original discovery of this locality is said to have been made so far back as 1864, and at different times several persons and companies have operated in the district, for the most part unsuccessfully because of metallurgical ignorance. Numerous open cuts, short tunnels, and shallow shafts have been made, demonstrating that the ore (a silicate) occurs in large quantities; while the extent of the veins is very considerable, the nickeliferous croppings at the summit of Piney mountain being in places eighty feet wide. About three thousand tons of ore have been mined, said to average five per cent. nickel, but some running as high as fifteen and twenty per cent. Mr. Austin thinks that it would be difficult to get any quantity of it that would average above eight per cent. from the present surface workings, the surface ore being decomposed and much of the nickel leached out. Thus far no serious metallurgical work has been attempted on the spot. A few carloads have been shipped away for experimental purposes. One of the mining companies had intended to concentrate the ores and smelt, but the low specific gravity of the ore (2.20 to 2.58) and its very friable character seem to preclude the use of wet concentration. Experiments have been made in ordinary lead-smelting furnaces, which were not at all suited to the high temperatures required; also in steel-melting crucibles, unavailable on account of the small quantities handled. Simple fusion in cupolas is not a practical solution of the metallurgical problem, because of the preponderating amount of gangue which it is necessary to flux off and the large quantity of fuel used. Mr. Austin notes the possibility of matting the ore with the help of nickeliferous pyrrhotite (from the neighborhood), to be afterwards blown in manhès converters. A 3 per cent. ore has been concentrated, however, by heating the crushed ore with a reducing agent to produce a magnetic combination, which is afterward extracted with a magnetic separator. Mr. W. Q. Brown, who applied this treatment, has also experimented in the line of converting the nickel into chlorid by roasting with salt and then leaching. Besides the methods mentioned, there are others which, as Mr. Austin says, perhaps lend themselves better to the object in view. If the ore is in sufficient quantity and of fair tenor, as the assay seems to indicate, the metallurgical difficulties will no doubt be overcome, as has been the case in New Caledonia and Canada.

These experiments illustrate some of the difficult metallurgic problems which often arise in the development of new mining properties.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Mining and Engineering Journals—See Introductory.

Metallurgy.

4751. The Development of Open Hearth Steel (This happy look into the future shows that 62 open-hearth furnaces, ranging from 5 to 50 tons capacity, have been built since 1894, and claims many advantages for these furnaces over the Bessemer converters). Ir Age-March 12. 900 w.

4768. Tests of Cast Steel Projectiles (A description of some cast steel, armor-piercing projectiles made by Messrs. Isaac G. Johnson & Co., that have shown remarkable results in government trials). R R Gaz-March 13. 900 w.

4780. How to Make Iron. R. W. Raymond (Lines read at the Pittsburg banquet of the Am. Inst. of Min. Engs. An odd combination of a grimy handed industry and poetic fervor in which the point made seems to be that members of the A. I. M. E. should be consulted in all things metallurgical). Eng & Min Jour-March 14. 1200 w.

*4789. The Works of Boël Brothers, La Louvière, Belgium. Ill. (The Bessemer steel is "poled" with an elm pole and the top of the ingot mold is fastened down with a single bent wedge. There are other novel features not usual in American practice). Ir & Coal Trs Rev-March 6. 600 w.

4852. Comparative Costs of Producing Pig Iron (New figures presenting the subject in a new light, from the 1894 Report of the Bureau of Industrial Statistics of Penna. (Ir Age-March 19. 700 w.

4853. New Jersey Fire Clays. Charles Ferry (A condemnation of the "bung" method usually employed in testing the refractory properties of clays). Ir Age–March 19. 1200 w.

4960. The History of Electric Heating Applied to Metallurgy. Frederic P. Dewey (Read before the Washington section of the Amer. Chem. Soc.). Elec Rev–March 25. Serial. 1st part. 2200 w.

4986. Analyses of Pig Irons Used for Different Purposes (Discussion on "Physics of Cast Iron" before the A. I. M. E. The composition is given for five uses to which foundry iron is put). Eng News–March 26. 700 w.

*5019. Investigations on the Influence of Low Temperatures on Iron and Steel. M. Rudeloff (Extract from "Mittheilungen aus den Koeniglichen Technsichen Versuchsanstalten zu Berlin" The author gives the results of previous tests and also those recently conducted at the Imperial Navy Yard at Wilhelmshafen). Mech Wld, Lond–March 20. 1500 w.

*5028. The Lixiviation of Silver Ores. John H Clemes (A paper read before the Inst. of Civ. Engs. The process employed at the Yedras mines in Mexico is described). Ind & Ir–March 20. 1500 w.

*5029. Mining and Treatment of Copper Ore at Tharsis, Spain. C. F. Courtney (A paper read before the Inst. of Civ. Engs. in which the method of mining and treatment are briefly described). Ind & Ir–March 20. 1200 w.

*5030. Tin Smelting at Pulo Brani, Singapore. John McKillop and T. Flower Ellis (A paper read before the Inst. of Civil Engs. It describes in an interesting manner the first successful attempt at competition with Chinese smelters of the Straits Trading Co). Ind & Ir–March 20. 1200 w.

*5045. The Bowling Iron and Steel Works (Description of a Yorkshire iron works started in 1780, but now compelled to shut down permanently). Ir & St Trs Jour–March 14. 700 w.

5046. The Effect of Coke Oven Construction on Coke. R. M. Atwater (A paper read before the Society of Engineers of Western Penna., setting forth the advantages of the Semet Solvay retort coke oven). Ir Tr Rev–March 26. 2500 w.

*5094. The Invention of the Bessemer Process (An interesting letter from Sir Henry Bessemer, replying to a paper read by Mr. J. D. Weeks before the Am. Inst. of Min Engs. He shows how Mr. Kelly, who it is claimed conceived the present Bessemer process, never produced any successful results and therefore invented nothing). Ir & St Trs Jour–March 21. 5000 w.

5102. Sulphur in Mild Steel. F. E. Thompson (The writer first briefly reviews previous investigations, and then shows the treatment of sulphur in the basic converter and in the basic open hearth furnace, giving a large number of analyses, tests, and other data). Ir Age–April 2. 3500 w.

5146. Matte Smelting. W. L. Austin (A general discussion containing a few new facts and numerous comments upon Mr. Herbert Lang's book on "Matte Smelting"). Min & Sci Pr–March 28. 3000 w.

†5171. Review of the Present Status of Iron Analyses. Gus C. Henning (Lecture delivered before the American Chemical Society, New York). Stevens' In–April. 3800 w.

*5179. The Invention of the Bessemer Process (Editorial discussing Bessemer's claim to the honor of inventing the process that goes by his name, in opposition to the assertion of the president of the American Institute of Engineers that he was not the original inventor,—the real inventor being an American named Kelly). Engng–March 27. 3000 w.

*5239. The Efficiencies of Gas Producers. Charles Frewen Jenkin (A paper read before the Inst. of Civ. Engs., being a historical summary of the various types of gas producers with the results of tests of cold gas efficiency shown in diagrams). Col Guard–March 27. Serial. 1st part. 2800 w.

*5250. The Causes of Mysterious Fractures in the Steel Used by Marine Engineers as Revealed by the Microscope. A. E. Seaton (Paper read at the 37th session of the Inst. of Naval Architects upon the results of an investigation of a broken shaft, concluding that the practice of boring out a shaft is a good one. Microscopic sections are shown and the report of an expert presented). Ir & St Tr Jour–March 28. 2000 w.

*5251. The Manufacture of Naval Forgings (Remarks upon American practice in high requirement forgings, giving some examples from the Bethlehem Iron Co). Ir & Coal Trs Rev–March 27. 1800 w.

*5252. Present and Prospective Ore Requirements of German Blast-Furnaces. E. Schrödter (Paper read before the *Verein deutscher Eisenhüttenleute*. The condition of the industry in each of the five districts in Germany is described, giving production and area of each). Ir & Coal Trs Rev–March 27. 2200 w.

†5254. The Demand and Supply of Iron in Japan. (Discussion upon an article in the *Japan Daily Mail*, by the ex-director of the Japanese Mining Bureau). Ir & Coal Trs Rev–March 27. 1000 w.

5255. The Direct Production of Iron and Steel. Carl Otto (Translated from *Stahl und Eissen*). Am Mfr & Ir Wld–March 20. 2500 w.

5256. The Baudoux and Gobbe Small Tank (Description of an innovation in the shape of a small capacity glass-melting furnace for the manufacture of window glass). Am Mfr & Ir Wld–March 20. 1300 w.

Mining.

4762. Gasoline Engines and Borax Mines (The successful application of these engines to an arid region and their adaptability to trying conditions are described. There is a cut of a direct connected air compressor, and a view of a borax mine). Min & Sci Pr–March 7. 800 w.

4763. The World's Greatest Gold Lode. Dan De Quille (A discourse upon the bigness of California gold prospects). Min & Sci Pr–March 7. 3500 w.

4781. The Labor Question in the Transvaal Mines. Pierre Leroy Beaulieu (Translated and abstracted from letter in *L'Economiste Français*. The article shows the labor market in a rather demoralized condition at present). Eng & Min Jour–March 14. 1400 w.

*4788. Lessening the Danger of Blasting in Fiery Pits. Franz Brzezowski (Abstracted from *Oesterreichische Zeitschrift für Bergund Hüttenwessen*. The safety measures at present at disposal are central fire cartridges, moss stemming, good cartridge covers, safety explosives, removal of coal dust by spraying, and finally skilled workmen). Col Guard. March 6. 1400 w.

4814. Georgia Marbles. William M. Brewer (The writer refers to several quarries and illustrates three of them). Tradesman–March 15. 600 w.

*4828. Some African Gold and Diamond Stealers (A very interesting article from the *South African Review* showing ingenious methods employed by professional robbers to unlawfully procure gold and diamonds). Aust Min Stand–Feb. 6. 1600 w.

*4829. The Victorian Alluvial Goldfield (A map of about thirty miles of alluvial district having the roads, claims, rivers and hills located with explanation in the text). Aust Min Stand–Feb. 6. 2400 w.

*4834. Anthracite Mining at the South Wilkes-Barre Colliery. W. W. Jones (Geological features, methods of mining, ventilating and drainage, etc., at an anthracite colliery of large capacity. Numerous cuts illustrate the geological formation, method of mining, ventilation, transportation, cars, and cages. It is a description of a typical plant). Col Eng–March. 8600 w.

*4848. Mining Permanency in New South Wales. W. H. J. Slee (Are our mineral deposits nearly exhausted and worked out? Does mining pay? These questions were answered by the chief inspector of mines, at the recent mining conference at Sydney). Aust Min Stand –Feb. 13. 1100 w.

*4850. Stones from Norway and Sweden. Herr Lund (This interesting article is illustrated by views from various granite quarries and gives one a good idea of the commercial and engineering sides of the industry). Stone–March. Serial. 1st part. 1200 w.

4873. A Dry Placer Machine (Illustrated description). Min & Sci Pr–March 14. 400 w.

4874. The Mining of Mica (A brief description of the method employed in North Carolina). Min & Sci Pr–March 14. 500 w.

4899. The Auriferous Gravels of the Upper Columbia River. Frank L. Nason (Describes the actual conditions under which the gold occurs and the method of working the placers and prospecting. Eng & Min Jour–March 21. 2400 w.

*4911. Statistics of Coal Production and Consumption (Tabular statements are presented giving the statistics of the British, Russian, Swedish, German, Belgian and French coal industries). Col Guard–March 13. 2500 w.

*4912. The Use of Safety Explosives in German Mines (Official report to the British Home Office of two of H. M. mine inspectors delegated to be present at the experiments made in Westphalia. The article contains a great deal of additional information on German mines). Col Guard–March 13. 3500 w.

*4913. Reports on the Blackwell Colliery Explosion (An investigation into the method of working the mine, and the cause of the explosion. Coal dust caused the disaster, being ignited by a blast). Col Guard–March 13. 3200 w.

4929. Unexplored Gold Regions. Dan De Quille, in *Salt Lake Tribune* (The article touches upon the fields of Thibet, Siberia, Mongolia, British Guiana and Venezuela). Min Ind and Rev–March 19. 2200 w.

*4934. The Extension of the Main Reef Westward of the Farm Witpoortje. Mr. Draper (Read before the Geol. Soc. of South Africa. An attempt at a geological explanation of the Witwatersrand formations). Min Jour–March 14. 4000 w.

*5015. Electric Driving for Works. Daniel Adamson (Paper read before the Manchester Assn. of Engineers. The application of electricity to various kinds of engineering work is ably discussed). Col Guard–March 20. 2300 w.

*5016. Separate Ventilation in Fiery Mines. Bergrath J. J. Mayer (The author treats of the ventilation of preliminary headings lying out of the direct line of the main air supply). Col Guard–March 20. 1300 w.

*5043. Russian Gold Mines (An extremely interesting article upon the railway projects and the methods used at the mines. Every mining man would do well to read the description of the novel method of concentration used). Mach, Lond–March 15. 3000 w.

5095. Nova Scotia Gypsum (The industry is briefly described in a general way, and the shipments given in quantity and value from 1890 to 1895; when 133,300 tons were sent out). Can Min Rev–March. 800 w.

5096. Ontario as a Mining Country. Dr. A. P. Coleman (A brief synopsis of the extent of the industry in the various mineral substances which the province produces). Can Min Rev–March. 3500 w.

5097. The Financial Aspect of Mining. J. H. Chewitt (An examination into the various causes which determine whether a mine will pay or not). Can Min Rev–March. 1500 w.

5098. Improvements in the Dressing of Gold Ores. F. Hille (This excellent paper describes the various up to date methods used in the concentration of fine material and gives illustrations of the Belharz, Spitzlutte percussion table, Laszlo amalgamator and Krupp's amalgamating table). Can Min Rev–March. 6000 w.

5099. Compressed Air at Sydney Mines, Cape Breton. R. H. Brown (The results of experience in a coal mine are given with description of plant employed). Can Min Rev–March. 1000 w.

5100. Experience with Air Compressing at Drummond Colliery, N. S. Charles Fergie (The underground pumps were driven by compressed air from a compressor located at the surface. The advantages are discussed). Can Min Rev–March. 1500 w.

5101. A Newfoundland Iron Deposit. R. E. Chambers (Paper read before the Min. Soc. of Nova Scotia. The deposits are located on Great Belle Island in Conception Bay and have been worked. The ore contains from 54 to 59% metallic iron). Ir Age–April 2. 1200 w.

5145. Gold Mining in Rhodesia. W. T. St. Auburn (An interesting description of methods and conditions in a South African gold district). Min & Sci Pr–March 28. 2700 w.

†5156. Problems of the Transvaal. Karl Blind (An article protesting against the policy of England in "grabbing" South African territory). N Amer Rev–April. 6500 w.

†5157. Gold Mining Activity in Colorado. T. A. Rickard (A very entertaining article showing the vicissitudes of Creede and Cripple Creek and the influences upon which the mining activity of the district depended). N Amer Rev –April. 3000 w.

*5236. Continuous and Automatic Sample-Taking of Air in Colliery Workings. Paul Petit (From a communication to the Société de l'Industrie Minérale, by the manager of the Saint-Etienne collieries. The apparatus used is described and illustrated by a diagram). Col Guard–March 27. 2000 w.

*5237. Horizontal Driving with the Aid of Congelation. M. F. Schmidt (Two methods were described before the Société de l'Industrie Minérale of Saint Etienne. One where the freezing pipeswere inserted around the periphery of the section, the other where the whole heading was frozen solid. A cut illustrates each method). Col Guard–March 27. 1600 w.

*5240. British Coal in France (In a Foreign Office Report, dated Feb. 13, 1896, Consul O'Neill, of Rouen, makes some observations with reference to the consumption of British coal in France, and the effect which the new railway tariffs are likely to have upon the trade, with colonial statistics). Col Guard–March 27. 1500 w.

*5253. The Mineral Resources and Railways of Cuba (A most interesting paper showing how the natural resources have been neglected and the general lack of interest in improvements). Ir & Coal Trs Rev–March 27. 1300 w.

Miscellany.

*4736. The Relative Value of Different Coals. H. M. Chance (Showing the qualities that give coal thermal value, and the methods and importance of testing them). Eng Mag–April. 3300 w.

*4737. Determining the Value of an Iron Mine. Nelson P. Hulst (A consideration, in the order of their importance, of the factors that influence the commercial worth of iron mines). Eng Mag–April. 3800 w.

4803. Notes on the Cerrillos Coal Field. John J. Stevenson (Abstract of a paper read before the N. Y. Academy of Sciences. Interesting description of a coal field in New Mexico, about 25 miles south from Santa Fé). Science–March 13. 1800 w.

*4830. An Age of Gold (An entertaining article from the *Manchester Sunday Chronicle* which says that this period will probably be known before the end of the century as the age of gold). Aust Min Stand–Feb. 6. 1300 w.

*4920. Cordite (This explosive was adopted by the British Government for the ordnance. Its properties are described at length). Eng, Lond–March 13. 2000 w.

*5017. The Recovery of Tar and Ammonia from Blast Furnace Gases. Andrew Gillespie (A paper read before the Inst. of Engineers and Shipbuilders, in Scotland). Col Guard–March 20. 3000 w.

*5018. The Estimation of Carbonic Acid in Flue Gases. A. H. Sexton (A paper read before the West of Scotland Iron and Steel Institute). Col Guard–March 20. 1200 w.

†5033. The Manufacture of Calcium Carbide. J. T. Morehead and G. de Chalmot (A full exposition of the processes used, with cuts of furnaces. Numerous experimental results are given). Jour Am Chem Soc–April. 5800 w.

†5034. Särnström's Method of Determining Manganese in Iron Ores. C. T. Mixer and H. W. Du Bois (This volumetric method gives results in about half an hour, and checks very closely with gravimetric methods). Jour Am Chem Soc–April. 1400 w.

5090. Experiments on the Action of Flameless Explosives upon Fire Damp and Coal Dust (The experiments conducted by the North of England Inst. of Min. & Mech. Engs. show that no commercial explosive is entirely flameless. The article contains an excellent illustration showing the apparatus employed). Sci Am Sup–April 4. 1000 w.

5164. Quarterly List of Tin Plate Works (An able compilation showing such progress in this industry in the United States as to give force to the prediction, given in editorial remarks and conclusions, that soon all that will remain to the foreign tin plate makers of their once magnificent American trade, will be the re-exporting business). Met Work–April 4. 2500 w.

†5165. An Occurrence of Free Gold in Granite. George P. Merrill (Description of a specimen in the national museum). Am Jour of Sci–April. 800 w.

*5238. Tertiary Pitch Coal at Wirtatobel, near Bergenz. Dr. Wilhelm von Gümbel, *Oesterreichische Zeitschrift fur Berg-und Hüttenwesen* (Description of some curious coal deposits at the northern foot of the Alps, in the molasse formation). Col Guard–March 27. 1200 w.

MUNICIPAL ENGINEERING

Pipe Distribution and Water-Supply for Fire Service.

MR. WILLIAM PERRY, writing in *The Canadian Engineer*, favors a gravity system for fire service whenever this can be obtained within a reasonable limit of cost. Such a system is always ready for service when required, an advantage not always secured by pumping directly into mains. While the latter system gives satisfactory service in many cases, Mr. Perry says that in other cases it has failed to respond promptly. He points out that from its nature it must depend upon some other means for ascertaining where its services are needed. Therefore, in order to afford the prompt supply that a reservoir gives, there must be the requisite pressure of steam, and the pumps must be always in readiness to act. The only way to secure reliable action of pumps at any moment is to have such a supply of these machines that they are never all needed at once, so that one or more of them may be stopped for needed repairs or adjustment, while the others are at work, without affecting constancy of supply. New systems constantly planned by incompetent engineers for young municipalities are reprehended, and such municipalities are urged to consult competent hydraulic engineers before constructing a water-works system.

"To secure an efficient and effective pressure for fire service the reservoir should be as near the city or town as possible to prevent the loss of head. With head sufficient to give 100 pounds pressure, or two hundred and thirty feet above the general level of the streets, there should be two mains for general delivery, made of cast iron and tested to three hundred pounds before being placed in the trench; said mains to connect to the general distribution supply in such manner that, should one pipe be in any way disabled, the other can be used instantly. The mains must be of such ample size that not more than 10 feet of head will be lost by friction, if all the hydrants in the system were opened at one time."

Mr. Perry gives a useful tabulated statement of the quantities of water that will be discharged per hour from nozzles of different diameters for stated pressure at the play pipe, the horizontal projection of the streams delivered, the vertical heights to which the streams can be thrown, etc. For these data the paper itself must be consulted. In conclusion, he specifies essentials for a good water-supply for fire purposes.

"Four-inch cast-iron pipe should never be used for a hydrant main. It will in a few years become so full of rust that it will not supply a 75-gallon stream, which is no use in case of fire. Concentration of water at a given point is of the utmost importance for fire service. The average consumption of water for household use varies from 40 gallons per day and upwards. For fire service it should be doubled in proportion. Where there is no drainage less water is used, and without drains and sewers waterworks should not be built.

"Stop-valves and gates should be provided, where convenient, on different sections of the mains for shutting off water in case of repair to broken mains. Accidents are liable to happen in opening streets; hydrants should be placed in locations easy of access and easy to be found in case of necessity. Brick cases should be built around every valve. Mains should not be laid less than six feet below the surface of the ground, and the earth should be well rammed down, removing all stones until the last or top layer. Where gravelly soil is found, pipe should go down seven feet deep, especially if traffic is carried on to any extent over it. All valves should be of the open pattern with brass spindles and square nuts for wrenches.

"Two-way frost case hydrants should be used on all cross streets, and in business or mercantile sections four-branch hydrants of a town or city should be used, and on the two-way hydrants not less than five-inch openings should be had, with faucet for connecting six-inch pipe. On the four-way hydrants there should be a seven-inch opening and an eight-inch pipe. This is one of the most important points for the fire distribution plant. There should be large waterways, and ample means of draining the hydrants when closed, to avoid freezing. A box should be built at the base with open bottom to enable the water to drain off, and, when possible, to run into a drain. The location of hydrants, as far as practicable, should be at the corner of streets, and they should be as close together and frequent as possible,—not over 400 feet apart. Hydrants are cheaper than hose, and they require less attention. Long lines of hose are detrimental to good fire service and to the proper working of the hydrant. Considerable bad work is done by contractors, who take hold of water works contracts, knowing nothing about the first principles of the work, and putting anything that is cheap in price. There should be a rule among corporations building a water-works system that no material should be put into the ground, or covered up, until inspected by a thoroughly competent hydraulic engineer and pronounced satisfactory. The chief engineer of the fire department should, while the work is progressing, make himself fully acquainted with the details of the work, and a plan should be furnished him to make him fully efficient. The only way to have matters right in fire systems is to pay particular attention to them. Where reservoirs cannot be had and pumping machinery is used, pumping machinery should be in duplicate, and located where supply is inexhaustible."

An Interesting Discussion on Naphthaline.

At the twenty-sixth annual meeting of the New England Association of Gas Engineers, reported in *American Gas Light Journal* (March 23), a discussion of the cause of the formation of naphthaline, and modes of preventing its formation, showed that the subject is one needing more systematic investigation than has yet been bestowed upon it. The discussion resulted in the appointment of a committee of investigation, whose report will be anticipated with interest. A member, in opening the discussion, said :

"I think, if we can reduce the temperature of the gas low enough as we send it into our mains, we shall have very little trouble from its formation. About two years ago I rigged up a condenser, and used that with well-water, and brought down the temperature of the gas the year round, or during the warm months of July and August, to 60°. My record during that time shows we had very little trouble with naphthaline. We removed it in this water-condenser. We took out a very large quantity once a month during the warm weather. Lately we have discarded that form of condensation, and have since had more or less trouble with naphthaline ; and during last season, commencing in August, we were closed up. Our mains, services, meters, and inside fittings were choked with it. We had as high as one hundred and fifty complaints a day. As a remedy, I propose to start in again with this water-condenser, hoping to leave the naphthaline in my yard instead of sending it out into the inlets and outlets of the holders, and into the mains and services. I believe it can be done, and I believe that is the remedy for this very great annoyance in our business."

In concluding his remarks, he strongly portrayed the present lack of knowledge upon the subject by saying : "I know of no other question about which we are all so much at sea as we are in respect to the formation of naphthaline. That table would not hold all the papers read and published on the subject; and in one respect we know as little about it to-day as we did twenty-five years ago. We know that it is in some way connected with condensation and temperature, but beyond that we know very little about it."

Another member said that some years ago, when one cold morning he happened to let a little of the benzine vapors and the oily vapors come right out against the cold water and in the chilly air, the formation of naphthaline was immense and instantaneous. Since then he has "always believed in the theory of that French chemist (M. Bremond) who said that naphthaline was formed by the sudden shock of hot gas against cold water. That is the way it formed at the end of the outlet from the tar-still that morning."

The president of the association declared his inability to throw any light upon the subject. Touching the extent of the trouble, and the desirability that both the causes of, and remedies for, it should be studied, he said: "I suppose we are all more or less interested in this question of what happens in the fall months which causes this trouble in the services—the trouble being universal throughout the States. Two years ago the trouble seemed to be very general indeed. Almost all the companies experienced it, and some of them had very serious trouble. It did not seem to matter whether a company was sending out plain coal gas, or plain water gas, or mixed gas,—the same trouble occurred with all. I am interested in this subject, because we want relief from this trouble in the coming year and the years to follow. I am also interested in it as I am in any problem which I am unable to solve, and I shall continue to be interested in it so long as we have the thing before us,—the formation of naphthaline in this very uncertain way. First, we may have it in our works; next we may have it in the holder, at the inlet, and outlet, and then we may have it in the supplies. We investigate it, and we think we have a clew to its formation, when suddenly we find that our gathered tables of information amount to nothing, because the opposite has been proved in some other location. This illusive character of the problem is what has annoyed me; and, to enable me to study the question more intelligently, after the general trouble which occurred this fall, I had some curves drawn on charts which show its extent in our city for several years past."

Most who took part in the discussion thought the formation begins with the first cool nights in the fall of the year, but one stated that, having examined the inlet and outlet pipes of the holder in the summer (August), he was greatly disturbed by discovering that the twenty-inch outlet was so badly stopped up that there was left scarcely a four-inch opening for the gas to pass through.

Another speaker spoke of the universality of the trouble. Every gas engineer had it to encounter. He said naphthaline forms in all parts of gas works at times, as well as in mains and service pipes. He suggested the employment by the association of a scientific man to make a special study of this formation. This excellent suggestion was not acted upon, the above-mentioned committee selected from members being appointed instead by the president.

Brick Paving for Country Roads.

Capt. W. S. Williams, at the seventeenth annual convention of The Ohio Tile, Brick, and Drainage Association, read a paper strongly advocating brick paving for public highways (*Clay Record*, Feb. 26). After giving his experience with a stone road extending from Fremont, Ohio, to Fort Crogan on the Sandusky river, he described the brick roads of the Netherlands, and finds the stone road far inferior to those famous highways. The stone road named has better gradients for its length, perhaps, than any in this or any other country. The road-bed proper was thrown up about three feet in height. A very thick coating of broken stone was then placed upon the road, excepting that part between Fremont and Bellevue, which was constructed mostly of gravel. Numerous toll gates were established as a means of revenue for repairs of the road. Having charge of this road for a number of years as State engineer, Mr. Williams asserts that it did not wear well; that it would cut into numerous ruts, when wet; and that, in dry weather, the wheels would pulverize the stone, which would be blown away in the form of dust. The rough broken stone was objectionable, until worn smooth; moreover, the road was a very expensive one to keep in order, the revenues scarcely sufficing for the purpose.

"The brick paving of the highways of the Netherlands was done so long ago that there are very few of the present generation who know when it was done. The material used was brick, but not as good as our best quality of shale. The repairs are very small; one man will keep several miles of this pavement in good order. It is apparent from experiments with different kinds of paved roadways that brick is the smoothest, most lasting, the cheapest, and the best.

"In any part of the country the alluvial formation of mixed gravel, sand, and sandy loam is sufficient for a foundation. Sometimes it may be necessary to add more sand or gravel, if convenient. Cinders, or anything which water can pass through readily, will do just as well as broken stone,—anything that will drain and not hold water, such as clay or its equivalents.

"It has never been found essential to put broken stone under a cobble-stone pavement, and a brick has certainly more square inches of bearing surface on the foundation than the average cobble-stone. Neither is it necessary to fill the interstices between the brick with coal tar, as it is plainly evident that brick will shed water more rapidly than cobble-stone, and coal tar is never used in a cobble pavement. The brick, with a plain sand filler, or its equivalent, will soon form a cement around and under the brick that will be impervious to water, and will become tough and hard.

"The road-bed should be thrown up with sufficient crown to shed water nicely, and then rolled with a heavy roller,—the heavier, the better. The ramming and pounding should be done on the foundation, and not on top of the brick.

"A dirt or summer road adjacent to the paved way should always be maintained. The paving brick should contain a large percentage of iron well distributed throughout the mass, and, where this condition exists, the brick will be found to be a homogeneous fused mass of great strength. A light colored brick shows the absence of iron. It is not necessary to have them repressed. As the repressing produces two different structures in the same brick, there will not be the same cohesive strength from center to exterior. The plain, ordinary standard-sized brick is the best."

Disposition of City Waste.

THE report of Col. George E. Waring, commissioner of the department of street cleaning, New York, to the mayor is a document of unusual importance and merit. The disposal of waste in a city of the first magnitude is a far different problem from what it is in a city of moderate proportions. The difference arises more from the enormous bulk to be handled and the distances to which it must be transported than from anything in the nature of the substances themselves, or in their mode of treatment. The subject needs, therefore, to be studied in relation to systemizing delivery, collecting, handling, and transportation, as much as with reference to methods of treatment of the collected substances. This report, accordingly, gives prominence to these features of the subject; at the same time, it discusses methods of disposing of collected waste, particularly garbage reduction and utilization.

An effort has been made to arrive at some better method than depositing wastes, by the scow-load, out at sea, and an investigation of different methods has been conducted, under Col. Waring's direction, by able assistants. Such methods as are in use in various cities have been critically scrutinized, and the literature of the subject has been explored by Mr. Macdonough Craven, Mr. Hawthorne Hill, and Mr. C. Herschel Koyl. Of the result of this systematic effort, Commissioner Waring says:

"While nothing like a definite conclusion has been reached, and while it is, in my judgment, by no means certain that a general contract for final disposition can wisely be entered into in the present state of our knowledge, I do think that more is known now than was known a year ago, and that there is a fair chance of our securing a good result in the letting of a contract for the incineration or utilization of garbage according to the specifications now advertised."

The report presents in concise form a summary of up-to-date information upon the disposal of city wastes. Its interest and value are enhanced by engravings of apparatus used in treatment of garbage in a number of cities. Dealing, as it does, solely with the disposal of waste, and being well indexed, it is a desirable work of reference for municipal engineers. Its literary style is much above the average of that usually found in municipal and department reports.

We understand that numerous inquiries for this report are coming in from municipal engineers throughout the country. It is to be hoped that Col. Waring will authorize the printing of a sufficient edition to supply the demand, as its high character merits a wide circulation. Both in manner and matter it may be commended as a model document.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Municipal Engineering in the American, English, and British Colonial Engineering and Municipal Journals—See Introductory.

Gas Supply.

†4785. On the Determination of Sulphur in Illuminating Gas and in Coal. Charles F. Mabery (Describes apparatus and a method thought to be more accurate and more easily applied than those in current practice). Am Chem Jour–March. 2800 w.

4787. Laboratory Apparatus for Testing Gas Coals.. G. Jouanne (Describes an apparatus that at each charge distils one kilogram of coal, collecting all products, thus enabling a complete analysis of the coal to be made). Am Gas Lgt Jour–March 16. 900 w.

4802. A Lecture upon Acetylene. J. M. Crafts (Delivered before the Soc. of Arts at Boston. Treats of its value as an illuminant; danger in use of liquefied acetylene; temperature of the flame; explosiveness, etc). Science–March 13. 9000 w.

4935. Should Gasholders in New England Be Housed or Not? Fred. H. Shelton (A practical paper opposed to housing holders of 300,000 feet capacity and upward. It is admitted that smaller holders may be sometimes housed with advantage. A discussion follows in which a considerable variety of opinion is expressed). Am Gas Lgt Jour–March 23. 8000 w.

4936. Naphthaline (A topical discussion by members of the New England Assn. of Gas Engineers, at its twenty-sixth annual meeting. A great variety of experience in the formation of naphthaline is given, and theories as to causes and modes of prevention are presented in the discussion, which resulted in the appointment of a committee to investigate the subject and present a report). Am Gas Lgt Jour–March 23. 2800 w.

4938. A Cheap and Reliable Exhaustive Governor. F. Egner (Illustrated description of a governor not patented and of which all parts, except the valve, can be made by any handy mechanic. In the writer's experience it has given better satisfaction than other forms). Am Gas Lgt Jour–March 23. 800 w.

5025. Utilizing Gas Liquor in Small Plants. B. P. Holmes (Paper read at meeting of Ohio Gas Lgt. Assn. Experimental results and conclusions, therefrom, with protracted discussion. First part gives the entire paper and a portion of the discussion. The paper gives description of apparatus and method). Am Gas Lgt Jour–March 30. 6500 w.

5161. Dots and Dashes. E. H. Jenkins (The paper deals in a rather rambling, but suggestive way, with practical points neglected or forgotten. Its suggestive character elicited a spirited and interesting discussion). Am Gas Lgt Jour–April 6 7000 w.

5162. Mains and Service: Their Extension and New Territory. George Light (An excellent paper outlining methods of procedure and mode of ascertaining whether a proposed extension will prove profitable to its constructors, with discussion). Am Gas Lgt Jour–April 6. 3600 w.

5163. Selling Gas. Henry L. Doherty (Holds that undue importance is assigned to the retort house as a source of losses, and points out where losses may come in along the whole line of operations until the consumer is reached.) Am Gas Lgt Jour–April 6. Serial. 1st part. 5000 w.

*5230. Gas-Pipes and Steam-Rollers. Norton H. Humphrys (Deals with the damaging effects of steam road rolling in gas-lighted towns, upon the gas pipes under streets. It appears that this has proved serious in some places). Jour Gas Lgt–March 31. 3000 w.

Sewerage.

4866. Alignment of Tile Sewer Pipe in Macon, Ga. (Illustrated description of devices and methods successfully employed). Eng Rec–March 14. 300 w.

4983. A Concrete Storm-Sewer in Brussels, Belgium (Interesting, instructive, illustrated description of large concrete works designed to carry the storm flow of a stream that flows through an important part of the city, and attains a great volume after each heavy rainfall). Eng News–March 26. 500 w.

*5024. The Disposal of Sewage and Refuse (Abstract of a lecture delivered by C. S. Cannell, before the educational department of the Norwich Co-operative Society. The declaration that the people of England are wasting a grand opportunity, is followed by suggestions of methods whereby the sewage now floated out to sea, may be utilized on land as a fertilizing agent). San Rec—March 20. 1200 w.

*5042. The East Molesey Sewage Works (General description of plant and methods with editorial remarks). Mach, Lond—March 15. 2500 w.

5133. Sewage Filter Beds at Waterloo, Ont. (Illustrated detailed description of a plant well adapted to the use of a small town). Eng News—April 2. 900 w.

*5155. Sewer Discharge and Velocity. Albert Wolheim (Formula, diagrams, and two tables, one giving proportional values of velocity and discharge for circular sewers at different depths of flow and when flowing full). Pav & Mun Engng—April. 300 w.

Streets and Pavements

*5153. Why Good Paving is Essential to the Success of a City. J. W. Howard (Facility of traffic which can only be secured by good paving, is assigned as the reason). Pav & Mun Engng—April. 1800 w.

*5154. From Cobblestones to Asphalt and Brick. N. P. Lewis (Specially condensed from official report to the chief engineer of Brooklyn). Pav & Mun Engng—April. 2800 w.

Water Supply.

*4732. Pure Water for Drinking and Cooking. S. P. Axtell (Showing the importance to municipalities of adopting a dual water-supply system). Eng Mag—April. 3200 w.

4760. Mr Mansergh's Report on the Water Supply of Toronto (A most interesting and instructive document. The writer is an eminent English engineer, employed by the authorities of the city to report on the supply of the city, and paid $15,000 for his services. In view of this large fee, and the high reputation of the author of the report, it will attract unusual attention). Eng News—March 12. 3000 w.

4774.—75 cts. The Water System of Burlington, Vt. F. H. Crandall (Very complete illustrated detailed description, followed by interesting discussion). Jour New Eng Water Works—March. 4500 w.

4775.—75 cts. On the Sanitary Condition Past and Present of the Water Supply of Burlington, Vermont. William T. Sedgwick (A very interesting and instructive paper. It gives results of analyses, and traces diseases that have prevailed in the city to organic impurities in the water taken from Lake Champlain). Jour New Eng Water Works—March. 5800 w.

4776.—75 cts. An Electrical Pumping Plant. Charles A. Hague (The incidental benefits that may attend the use of electricity for pumping are noted, and it is shown that for some situations, electrical power pumping may be cheaper than the direct use of steam. The data given and conclusions drawn will however fail to obtain general acceptance. An interesting discussion that exposes some vulnerable points accompanies the paper). Jour New Eng Water Works—March. 7000 w.

4868. Mr. Mansergh's Report on the Toronto Water-Works (Editorial review and summary of this able document). Eng Rec—March 14. 2300 w.

4877. Pipe Distribution and Water Supply for Fire Service. William Perry (The different systems in use are named and preference given to the gravity system. The carrying out of such a system in all its details forms the subject of the body of the article). Can Eng—March. 1400 w.

4889. Erie, Pa., Water Works (Illustrated detailed description). Fire & Water—March 21. Serial. 1st part. 800 w.

4890. New Pumping Station, Allegheny City, Pa. (Illustrated description). Fire & Water March 21. 600 w.

4895. The Syracuse Water-Works (Illustrated detailed description). Eng Rec—March 21. 4000 w.

*5014. London Water Supply (Editorial review of a bill introduced into the House of Lords, providing for vesting the water supply of London in a public trust). Engng—March 20. 2000 w.

5037. The Specifications for the New Bedford Force Main (These specifications are for a main eight miles long and forty-eight inches diameter, of riveted steel). Eng Rec—March 28. 1400 w.

5038. Mr. Allen Hazen's Report upon the Jersey City Water Supply (The conditions of obtaining a good water supply for Jersey City make the problem one of such difficulty that this report, dealing with these conditions, is of more than ordinary interest. The practicability of a filtered water supply is specially discussed and is viewed favorably, and the cost of such a plant is placed at $1,235,000). Eng Rec—March 28. 1800 w.

5134. The Feasibility and Cost of Purifying Badly Polluted Water (Editorial review of the report made by Mr. Allen Hazen, for Noyes and Hazen, of Boston, on the feasibility of a system of filtration of water for Jersey City water supply, and an estimate of its cost). Eng News—April 2. 2400 w.

5147. Record Making Pumping Engine, Chestnut Hill Pumping Station, Boston, Mass. (Illustrated detailed description, dealing exhaustively with an exceedingly instructive and interesting design, and tabulated data obtained from an exceedingly thorough test. The extraordinary result of one steam horse power per hour, on a consumption of 1.146 lbs. of coal is recorded). Power—April. 3300 w.

5247. The New Pump at the Lewiston Water-Works. Charles L. Newcomb (Illustrated detailed description of pump driven by water power. The whole question of design in a pump of this kind, with its special requirements, was dealt with). Eng Rec—April 4. 1400 w.

Miscellany.

4808. The Legal Status of Electrical and Gas Enterprises in Massachusetts Defined. E. W. Burdett (Abstract of an address before the Electric Potential Club at Boston). Elec—March 11. 2200 w.

RAILROADING

Articles of interest to railroad men will also be found in the departments of Civil Engineering, Electricity, and Mechanical Engineering.

The First Railway in China.

So little is known of the internal affairs of China that a few notes from Mr. Sheridan P. Read, United States consul at Tien-Tsin, from the *Engineering News* (Feb. 27), may be of interest.

"Seventeen years ago the only semblance of a railway in the whole Chinese Empire was an iron tramway, about 10 miles long, at the Kaiping coal mines, 80 miles from Tien-Tsin. Small cars loaded with coal were pushed over this tramway by coolies, who received 10 cents in Mexican silver for 12 to 14 hours' work per day. About this time the works were placed under the charge of Mr. Claude W. Kinder, M. Inst. C. E. and M. Am. Soc. C. E., an energetic young English engineer, who at once ventured to propose many changes tending to increase the efficiency of the plant and to decrease expenses. The Chinese directors of the mines did not regard his efforts with favor, and the Peking government promptly vetoed his attempts at progressive measures. But, despite the Peking authorities and native superstitions, Mr. Kinder determined to have a locomotive, if he had to build it himself, and he did build it. Four small driving wheels were ordered from the United States; a disabled stationary engine furnished the boiler, and a broken-down winding engine the cylinders. With few tools and little outside help these parts were fitted together, and the 'Rocket' was at last put upon the track with great yellow dragons emblazoned upon its sides. It was the first locomotive in China, and was a startling object to the Chinese, who expected all manner of dire consequences as the result of the innovation. The Peking authorities were horrified and at once ordered the Rocket dragon to be summarily suppressed. But the Chinese mine directors permitted it to be used in short trips inside the yard, at first, and its travels were gradually extended without producing the war, pestilence, and famine expected. At last imperial permission was granted for its free use.

"This was the beginning of railways in China, and the builder of the first locomotive is now chief engineer and superintendent of the Imperial Railways of China. The line, as at present finished, begins at Tien-Tsin; it then passes 27 miles to Tongku, 6 miles from the mouth of the Pei-ho, at the Gulf of Pechihli. From Tongku the line swings northeast to Shang-Hai-Kuan, the terminus of the present operated road, and 177 miles from Tien-Tsin. Surveys have been made for an extension of 200 miles beyond Shang-Hai-Kuan, and about 10 miles have been built. When finished, the railway is to reach Kirin, the center of Manchuria, and a branch is to be built to the head of the Gulf of Liaotung, where there is a good harbor. Active work on this line was interrupted by the late Chinese-Japanese war.

"The greater part of this railway runs through a flat, alluvial country, subjected to heavy floods during the rainy season. The sharpest curve has a radius of 1,000 ft., and there is only one of these, made necessary to avoid two cemeteries. The most of the curves have not less than 3,000 ft. radius, and the maximum gradient is 0.75 %. The country traversed is strictly agricultural, with no large towns, and the people are very poor. The Kaiping coal mines are the only mining industry in operation, though deposits of coal, iron, gold, and silver only await intelligent development. All trains are 'mixed' freight and passenger, with four trains each way daily from Tien-Tsin to Tongku, and one train daily from the latter point to the terminus. The average speed is 15 miles per hour, and, while the road has paid its running expenses, it yields no interest on its first cost of construction and equipment.

"The building was done after English methods and ideas of permanency, without regard to first cost or work required of it. No wooden structures find place upon it, stone, brick, concrete, and steel being the materials used.

"The wages paid are as follows, all payments being at the rate of Mexican silver: common laborers, $4 per month; firemen, $5 to $6; enginemen, $14 to $45. The two highest-paid native enginemen now on the road receive $41 and $46 per month, while an English engineman receives $200 per month, as a maximum. The section-hand receives $4 per month; foreman, $6; a native clerk, $80, if he can speak and write both Chinese and English. The cost of timber is very great, and wooden trestles are out of the question. All station houses are built of brick, plastered inside, for the same reason, and station platforms are made of stone or concrete filled in with earth and cinders."

Hydraulic System for Working and Locking of Railway Points and Signals.

THE importance of a reliable switch and signal service is recognized by all railway men, and the following description will, no doubt, prove interesting, particularly since the system described has been in successful operation for years. *Engineering* (London, Mar. 6) thus describes it:

"Instead of the points and signals being moved by means of rigid rods and wires, as hitherto done, involving considerable effort on the part of the signalmen in pulling over the levers, particularly when the points and signals are at very great distances from the cabin, they are worked by means of fluid under pressure, preferably a mixture of water and glycerine, conveyed by means of small pipes laid underground to double pistons fixed near the points, or to small single pistons attached to the signal-posts, the necessary power being generated by a pump worked by hand, steam, or gas, as circumstances render necessary or convenient. The power so generated is stored up in an accumulator ready for use. By this system the working of points, however distant they may be from the station or cabin, is accomplished without any physical effort on the part of the signalman; the little levers used for turning on the pressure can be moved by a child; the number of signal cabins and signalmen can be reduced; station yards are kept clear of the usual multiplicity of rods, rollers, cranks, compensating levers, and other mechanism; smaller cabins are required; in fact, the little levers can be, and are frequently, fixed in the station-master's office or some room in the station buildings, and so considerable economy is effected.

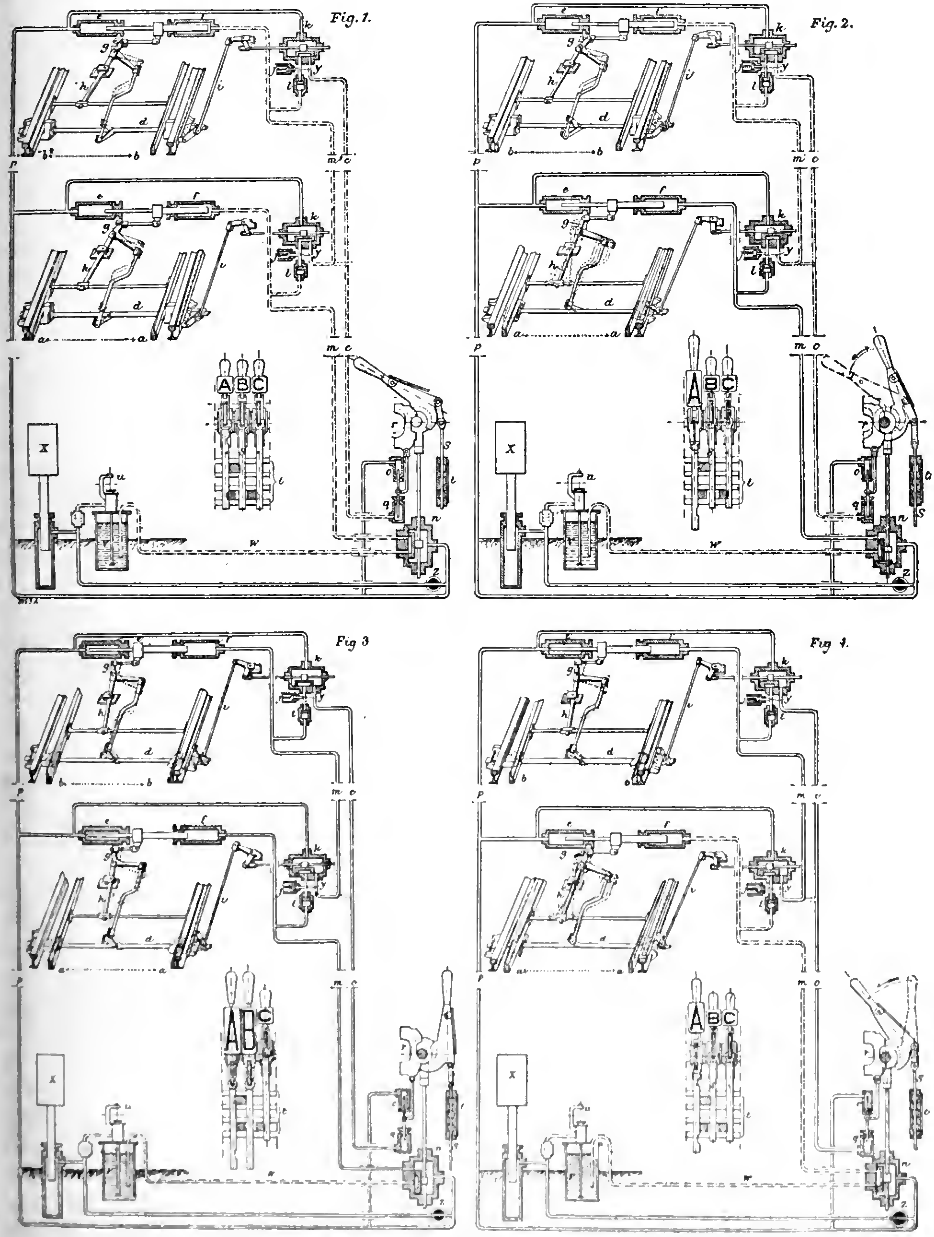
"It is obvious that it is of most vital importance that, whilst points are moved to and fro with the greatest facility, means should be provided for securing them firmly in position before a train is allowed to pass over them, and for assuring the operator that such closing and locking of the points has been perfectly accomplished. This very important object is attained, by the system under review, in the most perfect manner. Each set of points is moved to and fro by means of two pistons, which are put in alternate communication with fluid under pressure and a discharge reservoir. When the fluid has moved the points by means of the pistons, it is allowed, by the opening of a valve worked by the point lock attached to the points, to pass back to the signal cabin, and, by means of a small plunger fixed to the lever-locking frame, to take a lock off the point lever, so permitting the operator to pull it completely over, releasing the signal lever, which can then be moved, and the signal worked to permit a train to advance over the points.

"The first and partial movement of the point lever turns on the fluid under pressure to the points, unlocks them, moves, and then locks them in their altered position, and, after this is accomplished, the fluid returns to the cabin and releases the point lever, which can then be pulled the remainder of its stroke for the purpose of releasing the appropriate signal lever. Thus an infallible detector is provided to every pair of points, and their movement is perfectly controlled, irrespective of distance.

"The mixture of a certain quantity of glycerine with the water obviates all difficulty from frost, and prevents all risk of the fluid freezing during the most severe winters. The apparatus in actual work has been subjected to very severe tests, with a temperature as low as 20 deg. below zero Fahr., and no inconvenience has been experienced from congelation."

The method of working, illustrated by the accompanying diagram, is thus described:

"The lever, A, is worked by hand in two movements. The first part of the movement (⅔ of the stroke) is unimpeded, and works the valve, *n*, causing the move-



HYDRAULIC SYSTEM FOR WORKING POINTS AND SIGNALS.

ment of the differential plunger, *e f*, which works the bolt, *d*, and the points, *a* and *b*. The second part of the movement (⅓ of the stroke) is dependent upon the position of the control lock, *r*, which separates the two movements.

"The lever, A, takes four positions, shown in the four diagrams,—that is, two controlled positions (Figs. 1 and 3), and two working positions (Figs. 2 and 4). The points, *a* and *b*, and the facing point lock, *d*, are hydraulically worked by the differential plunger, *e f*, the working of which causes three successive movements:

"1. The unbolting of the points by the first rotation of the facing point lock, *d*, by means of the crank, *g*.

"2. The movement of the points by the lever, *h*.

"3. The bolting of the said points by the second rotation of the facing point lock, *d*.

"It will be noticed that each locking block is mounted centrally on the rod, *d*, and that each is broad on one side and narrow on the other. The broad portion interposes between the rail and the point when the point is open, whilst the narrow portion comes up outside the point, jamming it against the rail when that point is closed. On unlocking the point as described, the rotation of *d* continues until the broad portion of the locking block bears on the underside of the closed point. Under these conditions it cannot move further, until the point has been moved over.

"The facing point lock, *d*, takes three distinct positions, two for locking the points (Figs. 1 and 3), and one allowing points to be worked (Figs. 2 and 4). The working of the lock, *r*, upon the point lever is done hydraulically and automaticcally by the facing point lock in its last movement. The facing point lock, *d*, by the link, *i*, acts on the control valve, *k*, and on the differential plunger, *o q*; this works the lock, *r*, which acts as a control or release lock on the point lever, A. In operating the plant, the signalman, if he desires to shift the points, first moves the point lever, A, over as far as the lock, *r*, will let him. During this motion the lever, A, mechanically locks the signal lever, with which the signals, corresponding to the original position of the points, are operated. At the same time the signals corresponding to the new position of the points still remain locked. As soon, however, as the points are locked in their new position, the control lock, *r*, on lever A, is raised by means of water admitted to the hydraulic plungers, *o*, *q*, through the valve, *k*, which is operated when the bar, *d*, locks the points. Knowing the points are thus secure in place, the signalman moves A over to the full limit of its travel, and in doing so unlocks the signals corresponding to the new position of the points. The interlocking of the signal and point levers is purely mechanical. The locking of lever C, which should not be moved at the same time as lever A, is accomplished by means of a horizontal tappet in the first sixth part of the stroke of lever A. This precedes the movement of the valve, *k*, controling the points, *a* and *b*. The releasing of the lever, B (which ought not to be released until lever A is pulled completely over), is accomplished by a horizontal tappet in the last sixth of the stroke of the lever, A.

"The accumulator, X, holding 1, 2, or 4 gallons, and arranged for 50 atmospheres' pressure, is sufficient for 50, 100, or 200 movements. The pipes are charged by a pump ordinarily worked by hand. A small gas engine of ¼ horse-power suffices for larger installations. The liquid (water and glycerine) employed is used over and over again, being brought back to the reservoir by a return pipe. When the accumulator is charged, the state of the hydraulic installation is readily seen. Should any leakage take place, it is shown by the falling of the accumulator.

"From the foregoing description it will be seen that this system of hydraulic working and locking of points and signals is extremely simple. In very many instances where difficulty is experienced in finding room for cabins of the ordinary kind and size, this system doubtless proves extremely valuable. The Tower Bridge was interlocked on this system by Messrs. Saxby and Farmer, Limited, of Kilburn, London, who are the manufacturers of the apparatus under the Bianchi-Servettaz patents."

Raising the Center of Gravity of Locomotives.

GOOD practice is a relative term depending largely upon local conditions, and so it happens that the type of locomotive we find the better does not at all correspond with the English or French ideal. Yet there are certain tendencies which are general, and foremost among these is the tendency to elevate the boiler and raise the center of gravity of the engine. Some time ago the *Genie Civil* published an article upon this subject, which was translated in the February number of the bulletin of the National Railway Congress and subsequently appeared in the *Railway Review* (Mar. 28); in it this subject is fully and intelligently treated. Of course the point of view is a French one, and interesting in consequence. Speaking of the height of boilers in express engines, the author places the height of the center of English boilers at from 7 ft. 5 in. to 7 ft 10¾ in. above the rail; in Belgium they have reached 7 ft. 9¼ in.; in Austria, 8 ft. 0¼ in.; while the maximum height in the United States is 8 ft. 11½ in.

To quote from the article: "The height nowadays regarded as the minimum in the United States is actually greater than the maximum in Europe. Fig. 1 shows in diagram on the same scale a standard French type of express engine compared with one on an American road, which gives a better idea than mere dimensions of how far the Americans have gone beyond us in the power and height of their engines. Also Fig. 2 shows front views of three classical types of engines,—an old Crampton, an express engine from the Midland of England, and one of the New York Central engines."

The advantages gained by height are given in these words: "When the flanges of the wheels of the locomotive strike the rail on a curve, everything else being equal, a jar is given which is all the more violent in proportion as the center of gravity is lower. If we suppose the center of gravity to be at a level with the rail, the strain due to the centrifugal force will be entirely transmitted to the rail; if the center of gravity were removed to an infinite distance above the permanent way, the engine would no longer have any stability, and, under the influence of an infinitely slight centrifugal force, would balance itself on the outer rail without causing any appreciable strain tending towards displacement. In practice, every engine occupies an intermediate position between these extremes, and we can draw the conclusion that, the higher an engine is, the less will it tend to displace the permanent way. To make it absolutely safe, we shall only have to give it the minimum stability consistent with its running no risk of being upset when

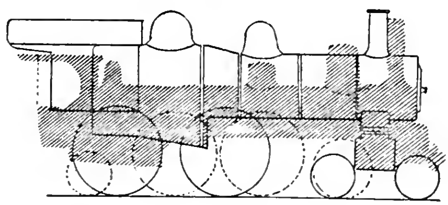


FIG. 1.

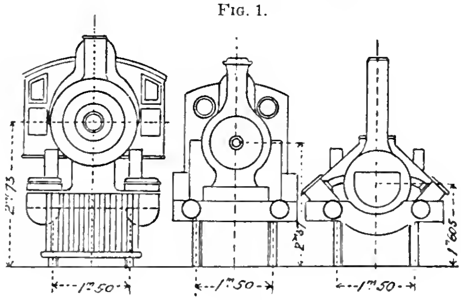


FIG. 2.

passing at full speed over curves of the smallest radius which it will have to pass; and experience shows that this limit is not exceeded by the most lofty American engines."

In enlarging upon the relation between raising the height of boiler and the center of gravity he makes the statement that, in a case cited, the center of gravity was raised but twenty-five per cent. of the increased height of boiler. The general conclusions arrived at are thus combined:

"1. Within certain limits, which have so far not been reached in Europe or even in America, raising the center of gravity of engines has nothing but good results. It results in decrease in strain on the permanent way and on the parts which go to make up the engine, wheels, axles, boxes, and frame plates. The running of the engine is made smoother because the springs come more into play under the action of lateral motion and in running around curves; the tendency to derailment is decreased by the increase of the load on the outer rail when curves are run over at a high rate of speed.

"2. Raising the boiler seems to be the most practical, the most simple, and the least costly method of increasing engine power, as it allows of the barrel having a diameter greater than the space between the tires.

"3. As the boiler does not, on the average, make-up more than one-quarter of the weight of an engine, if it be raised a given amount, the center of gravity of the whole is only raised about a quarter of this amount.

"4. The center of gravity of the highest engines used at present is much lower than that of passenger carriages and loaded wagons; it can, therefore, be considerably raised without fear of endangering safety."

The New Tramway.

IN order to overcome the evils of the trolley system, the annoyances of steam traction, and the cost of cable roads, the "Compagnie des Omnibus" of Paris have devised a compressed-air system, which possesses many advantages. Vol. 1, No. 1, of *Compressed Air* (March), a bright little house organ devoted to the "useful application of compressed air," contains a translation from the *Figaro*, in which the road referred to is briefly described as follows: "Though of light weight and graceful form, it is sufficiently strong to draw several cars and accommodate forty passengers." It can back, stop quickly, and start with equal facility, and is free from disagreeable noises and odors.

"At starting, the tramway is charged with a sufficient quantity of compressed air to enable it to run for four kilometers, beyond which distance it becomes self-charging and by the following ingenious device.

"Before each waiting station the rails are provided with a pipe, which is set in the hollow over which the wheels pass. The wheels cause a smaller pipe to spring from the ground and enter a hydraulic joint placed under the tramway, by which means the receivers installed there are connected with the underground conduit. The amount of compressed air received in a few seconds is sufficient to propel the motor car for a further distance of four kilometers. This done, the small pipe returns beneath the surface, and is automatically covered with an iron plate, over which men and horses alike may pass with perfect safety."

This system has been adopted at Saint-Quentin, Angouleme, and Lyons.

SPEAKING of the influence which the advances now in progress in Japan are likely to exert upon surrounding oriental nations, of the signs of an awakening in China now plainly perceptible, and of its probable effect upon American trade, *Locomotive Engineering* (April) says:

"Adversity often stirs up nations and individuals to efforts formerly thought beyond capacity. The hammering which China received from Japan seems to have stirred the Celestial Empire into sentiments of progress that a thousand years of peace would have failed to excite. The first manifestation of this is the report that the Chinese Government has signed a contract with an Anglo-American syndicate to build a railway from Hankow to Pekin, a distance of 700 miles. This line has been contemplated for some years, and was sanctioned by the emperor in 1889. Chinese public sentiment, however, is strongly adverse to the introduction of modern methods, and every obstacle has been placed in the way of this enterprise. The completion of and operation of a real railway in China—for the pioneer road now running from Tientsing is chiefly a coal carrier and has little but local business—will doubtless work a revolution in sentiment and ultimately result in a very large amount of railway building in the great empire, in which American builders and operators will have no small share."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Railroad and Engineering Journals—See Introductory.

*4729. Railroad Corporations in Practical Politics Cyrus C. Warman (Showing that the efforts of railroads to control politics in their interest are in the long run unprofitable). Eng Mag-March. 3500 w.

*4733. The Future of Elevated Railroads. Eugene Klapp (Showing how the construction and operation of elevated roads may be sufficiently cheapened to make them practicable in cities of the second and third ranks). Eng Mag -April. 2800 w.

4756. A Combination Steam and Electric Locomotive (This engine is unique in design. It consists of a box-car-like structure on wheels containing an engine run at high economy, which drives dynamos furnishing current to the motors attached to the driving wheel axles. It is intended for main line work and does away with the trolley system). Eng News-March 12. 500 w.

4757. Colors for Night Signals (Abstract of report of committee of the Railway Signaling Club. They recommend that the present system of red for danger, green for caution, and white for clear, be retained, but that the danger of colored glasses breaking be reduced, and that the colors should be so decided as to be unmistakable). Eng News-March 12. 1800 w.

4758. The Size and Capacity of Freight Cars for Interchange Service (Editorial discussion of the report of the special committee on " Large Cars," to the N. Y. Railroad Club. Some interesting figures are given on weights and dimensions of cars on various roads). Eng News -March 12. 1800 w.

4759 The Supreme Court Commission's Report on the New York Rapid Transit Ry. (The most important work now under way in the United States. The editor summarizes the history and present status of the scheme and makes extracts from the report. The underground system estimated to cost less than $50,000,000, is fully discussed). Eng News-March 12. 3800 w.

4761. The Hoskins Gasoline Motor for Street Cars (This motor car is built in the United States and is being tested at Dayton, Ohio. All machinery is beneath the body of the car, the engines are in motion constantly and engage with the drivers by means of friction pulleys). Eng News-March 12. 700 w.

4766. Wear of Tires on the Passenger Engines of the New York Central & Hudson River Railroad for the Past Twenty Years (A valuable paper by Mr. P. H. Dudley, with tables and diagrams, showing the influence of the modern rail with a broad head, on the wear of locomotive tires. It is shown that the engines running on the old 65-lb. rails made 19,400 miles for each sixteenth of an inch worn off the driving tire; while engines running over the more recent broad headed rails, and in part over rails weighing over 100 lbs. to the yard, showed an average of 29,046 miles for each sixteenth of an inch tire wear). R R Gaz-March 13. 2500 w.

4767. Some Railroad Matters in England (A summary by Mr W. M. Acworth, of recent railroad matters in England, covering legislation with regard to light railroads, some long and fast runs and improvements in passenger rolling stock, together with other matters). R R Gaz-March 13. 2500 w.

4770. Drop Smoke Stacks for Roundhouses (A description of the drop smokestack as used on the Chicago, Burlington and Quincy Railroad, with detailed drawings). R R Gaz-March 13. 600 w.

*4782. Modern Engines of the Brighton Railway. Ill. W. B. Paley (The article gives a good idea of the types of engines which an English road finds it necessary to adopt to meet its varied traffic demands). Ry Wld-March. 2500 w.

*4783. A Rural Steam Tramway in Sussex (A private enterprise in the line of light railways. The gauge is 3 ft., and the road is fitted with 26 lb. rails, and is 1¾ miles long. The traffic is entirely local). Ry Wld-March. 1300 w.

*4784. American Experiments with Electric Conduit Tramways (The editor discourages such installations, giving his reasons). Ry Wld-March. 1400 w.

*4791. Hydraulic System for Working and Locking of Railway Points and Signals (A very simple and compact method is here given and illustrated by cuts of the levers, valves and gears). Engng-March 6. 3300 w.

†4794. Report of the Committee on Large Cars (The article is especially valuable as containing the letters printed in full which the Committee received from various authorities on railroad matters and which contain interesting data). Pro N Y R R Club-Feb. 20. 22000 w.

†4795. Report of the Committee of Mechanical Superintendents, Appointed by the Central Traffic Association and the Western Freight Association (A report on the dimensions of freight cars. The tabular statements of various loads are interesting). Pro N Y R R Club-Feb. 20. 1800 w.

†4796. Report of the Western Classification Committee (A lengthy discussion among the various members on the limiting of size and weight of freight cars). Pro N Y R R Club-Feb 20. 13000 w.

4815. A Suggestion for Testing Street Railway Motors. George T. Hanchett (Illustrated description of an apparatus which is designed to effectively accomplish a thorough electrical testing of the car in a systematic manner, the amount of time consumed being negligible). Elec Ry Gaz-March 14. 800 w.

*4851. Third Rail and Feeder Equipment of the Lake Street Elevated, Chicago (The method of construction is fully illustrated and described). St Ry Rev–March 15. 600 w.

4869. A New Tramway Rail (The rail adopted for surface railways in N. Y. City. The lip is raised to a level with the head, thus offering no obstruction to traffic). Eng Rec–March 14. 400 w.

4878. Railroad Enterprise in China (A letter to the editor from Shanghai, supplemented by information gleaned from other sources, concerning the present status of railroad building in China). R R Gaz–March 20. 1600 w.

4879. Tonnage Rating of Locomotives (Discussion before the Northwest Railway Club, showing testing and rating methods adopted by various roads, and the advantages of rating locomotives by the weight rather than by number of cars). R R Gaz-March 20. 1900 w.

4880. Experiments with Locomotive Exhaust Pipes and Smokestacks (An account of some very elaborate experiments made in Germany, in the years 1892 to 1894, to ascertain the effects of different shapes and proportions of exhaust pipes and smokestacks for locomotives. A very elaborate investigation). RR Gaz–March 20. 4000 w.

†4898. Automatic Brakes for Goods Trains (Recommending the use of continuous brakes as a safety measure, with reasons supporting the position taken). Ind & East Eng–Feb. 22. 1500 w.

4901. Rapid Transit in New York (Showing how the present laws must be modified in order to induce a contractor to take up the work of building an underground railway in New York city). Bradstreet's–March 21 600 w.

4902. Improved British Railway Returns (The returns from the various roads show a general increase in revenue). Bradstreet's–March 21 500 w.

*4919. Railway Economics (Showing why the operating expenses are higher and the receipts per mile of road are lower than in other countries). Eng, Lond–March 13. 1500 w.

*4924. Triple Cylinder Locomotives (A glance at our American compound locomotives from an English standpoint). Eng, Lond–March 13. 2000 w.

4930. Boston's New Union Station (This station and train-shed will be the largest in the world. It will have twenty-three tracks, and cover an area of 495.000 sq ft. Interesting figures concerning other stations are given). Bos Jour of Com–March 21. 900 w.

4932. Distant Signals and Care of Interlocking Apparatus. Charles Hansel (Letter to the editor taking the position that the power to change signals should be taken from the operator after the train has entered the interlocking limits). Ry Rev–March 21. 1500 w.

4933. Louisville (Ky.) Terminal of the C. C. C. & St. L. and the C. & O. Railways (Description, illustrated by track plan, view and cross section). Ry Rev–March 21. 1500 w.

4962. Some Recent Developments of the Trolley (Illustrated description of mail and express cars and of an electric trolley snow plow). Sci Am Sup–March 28. 1400 w.

4965. The Gorge Road at Niagara Falls (An illustrated description of the Gorge Railroad, which is designed to prove a great attraction to all lovers of natural beauty). Sci Am–March 28. 1200 w.

4981. An Electric Inclined Railway at Great Falls, Mont. (A counter-balanced incline railway 400-ft long, and on an incline of 22° 10″ with the horizontal). Eng News–March 26. 400 w.

4988. Gate for the Wallabout Drawbridge, Brooklyn, N.Y. (An ingenious device by which a wide gate can be quickly closed and not occupy much space. The article is illustrated by views and detail drawings). Eng News–March 26. 900 w.

4990. Proposed Southern Union Station in Boston (A general description of a plan for a new union railroad station in Boston, on a very extensive scale, showing location in general. and arrangement of tracks and head house). R R Gaz-March 27. 1500 w.

4991. Signal Standards on the Pennsylvania Lines West of Pittsburgh (A description with diagrams, of the arrangements adopted as standard for the disposition of signals, together with a statement of the principles governing the arrangement. An important illustration of the subject). R R Gaz–March 27. 1000 w.

4992. The Hauling Capacity of Locomotives. H. H. Vaughan (Extracts from a paper presented before the Northwest Ry. Club, explaining the methods of rating locomotive loads adopted on that road. For some time it has been the practice to load locomotives by actual tons rather than by the number of cars). R R Gaz-March 27. 2500 w.

4997. A Surface-Contact Street Railway System (Illustrated description of an interesting system now in course of experimental test on 34th st, N. Y. The latest Johnson-Lundell system). Elec Wld–March 28. 900 w.

*5020. A Forgotten Chapter in Railway History. G. A. Sekon (The discussion of combined locomotive and railway carriage construction, giving cuts of two designs planned by W. B. Adams, about 1848). Mech Wld, Lond–March 20. 2300 w.

†5026. The Zone System (An interesting report showing the tendency in the distribution of passenger traffic in Hungary, with editorial comments). Ind & East Eng–Feb. 29. 1800 w.

5047. Advantages of Raising the Center of Gravity of Locomotives (From the Bulletin of the National Railway Congress, showing the increased safety gained in high engines). Ry Rev–March 28 1200 w.

5048. The Hauling Capacity of Locomotives (Extracts from discussion on a paper by H. H. Vaughan of this title read before the Northwest Railway Club). Ry Rev–March 28. 3200 w.

5049. Piece Work in Car Shops. G. L. Potter (Abstract of a paper read before the Western Railway Club advocating piece work). Ry Rev–March 28. 2000 w.

*5059. The Rouen Electric Tramways (Illustrated description of the largest network so far equipped for electric traction in France). Elec Eng, Lond–March 20. 2600 w.

†5081. The System of the Orleans Railroad Company, New Orleans, La. Ill. (A thorough description of plant and operation. One of the novel features is a road bed construction on swampy ground, the bottom of the excavation being floored with cypress planting). St Ry Jour–April. 3800 w.

†5083. The Design of Testing Stations for Street Railways. R. W. Conant (The importance and character of such a station is intelligently treated and the installation of the West End St. Ry. of Boston is described. The subject of insulation is given special attention). St Ry Jour–April. 4500 w.

†5084. English Methods of Cable Track Construction. Alex. McCallum (English and American methods are compared showing greater economy as lying on the side of the English type). St Ry Jour–April. 1800 w.

†5085. Car House Construction in Boston (Each part is described and illustrated by place and section. The design embodies the results of long experience). St Ry Jour–April. 1100 w.

*5105. Philadelphia and Reading Shops. A. S. (The history of this well known shop is related, and the present equipment is described). Loc Engng–April. 2800 w.

*5106. Old B & O. Engines (Illustrations of five curiosities in locomotive practice). Loc Engng–April. 200 w.

5110. The Electrical Equipment of the Orleans Railroad, New Orleans, La. (Illustrated description). Elec Eng–April 1. 3000 w.

5123. Interlocking at Toronto (A short description, with illustrations, of the interlocked switches and signals recently installed in the yards of the Grand Trunk Railway in Toronto. The material used is English and this plant is the largest and most important installation of English signal apparatus in this country). R R Gaz–April 3. 800 w.

5124. Colors for Night Signals (An abstract of a committee report and discussion on this subject, before the Railway Signalling Club, Chicago, also an editorial on the same subject). R R Gaz-April 3. 2400 w.

5126. Lubricating Rails on Curves (A short account of some recent experience in Germany with the use of lubricants on the gage side of rails on very sharp curves. A considerable reduction in wear of material and in power expended in hauling is obtained at trifling expense). R R Gaz–April 3. 600 w.

5127. The Supreme Court Decision in the Brown Case (A short editorial discussion of the recent decision in this celebrated case. This is the case which has been fought for some years between the Interstate Commerce Commission and the railroads, involving the right, under the constitution, of a witness to refrain from giving incriminating testimony. The Supreme Court of the United States now upholds the Interstate Commerce Commission in the contention that officers of the railroads must give testimony and rely upon the provisions of the law of Feb. 11, 1893, for protection). R R Gaz–April 3. 1100 w.

5131. Rules for Operation and Maintenance of Interlocking Signals (Report of H. D. Miles, W. C. Nixon, and Henry M. Sperry, committee for the Railway Signaling Club, Chicago. The rules are concise and condensed). Eng News–April 2. 2400 w.

5152. The New Tramway. Charles Chincholle (Translated from *The Figaro*, showing how compressed air is utilized in street car service in Paris). Compressed Air–March. 700 w.

5181. Track Elevation—N. Y. N. H. & H. R. R. in Boston. (Illustrated detailed description of plans). Ry Rev–April 4. 1200 w.

5183. Ornamentation in Locomotive Painting. A. Ashmun Kelly (The writer discourses upon the aesthetic effect on the enginemen and cleaners). Ry Mas Mech–April. 900 w.

5184. The Piece Work System (The system adopted by the Baltimore and Ohio R. R. is explained and a schedule of prices paid for a large number of separate parts is presented). Ry Mas Mech–April. 600 w.

5185. Further Details of Sand House at Argentine, Kansas (Illustrated description). Ry Mas Mech–April. 150 w.

5186. A Notable Water Tank Installation (Tank at Elmhurst, on the Chicago & Northwestern Railway. The controlling ideas in design were quick delivery of water, durability and cost. Drawings of the valves and pipe connections are given with a view of the tank). Ry Mas Mech–April. 550 w.

5231. Chicago & Northwestern Locomotive Testing Plant (Illustrated detailed description). R R Gaz–April 10. 1300 w.

5232. New Interlocking Machine of the National (Illustrated detailed description). R R Gaz–April 10. 700 w.

5233. McPherson's Safety Switch and Frog (Illustrated detailed description). R R Gaz–April 10. 400 w.

5234. The Question of the Big Car (Discusses the effects of increase of length of box cars, as being increase in earning capacity and decrease of operating expenses. But as this is only one side of the question, the writer concludes with a series of formulated questions designed to elicit discussion of other phases of the subject). R R Gaz–April 10. 1700 w.

5235. Conditions Affecting the Future of Our Railroads. George B. Leighton (Notwithstanding the merited or unmerited adversity brought upon railroads by the recent commercial depression, an examination into the present status of railroads in the United States, leads the author to conclude that very many of the lines at present constructed will prove safe investments as to their bonds, and many of them will regularly pay fair returns on their stock). R R Gaz–April 10. 2200 w.

*5243. Details of the Fast Run on an American Railway (The run on the Michigan Southern Railway, Oct. 1895. is described, giving profile of route and full details). Eng, Lond–March 27. 1100 w.

SCIENTIFIC MISCELLANY

Rontgen Rays Reflected.

Two prominent American scientists have succeeded in reflecting these rays. Professor Ogden N. Rood, of Columbia University, in *Science* (March 27), and Mr. Nikola Tesla, in *Electrical Review* (March 18), claim to have demonstrated this property of the rays, and to have made good shadowgraphs by reflected Röntgen rays. Mr. Edwin B. Frost, of Hanover, N. H., also announces, in *Science* (March 27), that he has succeeded in "repeating Röntgen's reflection experiment, except that a celluloid film was used instead of a less permeable glass." In describing his experiments Professor Rood says:

"The apparatus employed was of the simplest character; a coil of moderate size, made by Ruhmkorff more than thirty years ago, was excited by a current suitable for class-room experiments, no condenser whatever being employed. The Crookes tube was of German make, and had originally been intended only for class demonstrations. With aid of a fluorescent screen, it had been carefully studied, and the best portion of it was employed. The reflecting surface consisted of a new sheet of ordinary platinum foil, which was held rather loosely against a plate of glass, no attempt being made to remove its accidental deformations, which were mainly parallel to the axis of the cylinder, which it had formed when rolled on its stick. These elongated deformations, convex and concave, were placed vertically."

Omitting Prof. Rood's description of the details of arrangement of plate-holder, etc., we quote further:

"After an exposure of ten hours, it was found that a good image of the netting had been produced on the vertical strip of the plate exposed to the reflected rays. This image had various deformations the vertical lines representing the netting being as a general thing most distinct; in some places, however, the horizontal lines had the upper hand, and there were a few spots where both were equally distinct. The image under those portions protected by two thicknesses of aluminum plate was perhaps a trifle fainter than that on the rest of the plate. These facts and the character of the deformations point very strongly to the conclusion that in the act of reflection from the metallic surface the Röntgen rays behave like ordinary light."

As a first approximation Professor Rood estimates that the platinum foil reflects a little less than $\frac{1}{200}$ of the rays.

Mr. Tesla, in his letter to the *Electrical Review*, states some very interesting facts, besides describing his reflection experiments. He says:

"I am producing strong shadows at a distance of forty feet; I repeat, forty feet and even more. Nor is this all. So strong are the actions on the film that provision must be made to guard the plates in my photographic department, located on the floor above,—a distance of fully sixty feet,—from being spoiled by long exposure to the stray rays. Though during my investigations I have performed many experiments which seemed extraordinary, I am deeply astonished in observing these unexpected manifestations, and still more so as even now I see before me the possibility, not to say certitude, of augmenting the effects with my apparatus at least tenfold. What may we then expect? We have to deal here, evidently, with a radiation of astonishing power, and the inquiry into its nature becomes more and more interesting and important. Here is an unlooked-for result of an action which, though wonderful in itself, seemed feeble and entirely incapable of such expansion, and affords a good example of the fruitfulness of original discovery. These effects upon the sensitive plate at so great a distance I attribute to the employment of a bulb with a single terminal, which permits the use of practically any desired potential and the attainment of extraordinary speeds of the projected particles. With such a bulb it is also evident that the action upon a fluorescent screen is proportionately greater than when the usual kind of tube is employed. And I have already observed enough to feel sure that great developments are to be looked for in this direction. I consider Röntgen's discovery—the enabling us to see, by the use of a fluorescent screen, through an opaque substance—even a more beautiful one than the recording upon the plate.

"Since my previous communication to you, I have made considerable progress, and can presently announce one more result of importance. I have lately obtained shadows by reflected rays only, thus demonstrating beyond doubt that the Röntgen rays possess this property. One of the experiments may be cited here. A thick copper tube, about a foot long, was taken, and one of its ends tightly closed by the plate-holder containing a sensitive plate, protected by a fiber cover as usual. Near the open end of the copper tube was placed a thick plate of glass at an angle of forty-five degrees to the axis of the tube. A single-terminal bulb was then suspended above the glass plate at a distance of about eight inches, so that the bundle of rays fell upon the latter at an angle of forty-five degrees and the supposedly reflected rays passed along the axis of the copper tube. An exposure of forty-five minutes gave a clear and sharp shadow of a metallic object. This shadow was produced by the reflected rays, as the direct action was absolutely excluded, it having been demonstrated that, even under the severest tests, with much stronger actions, no impression whatever could be produced upon the film through a thickness of copper equal to that of the tube. Comparing the intensity of the action with an equivalent effect due to the direct rays, I estimate that approximately two per cent. of the latter were reflected from the glass plate in this experiment."

Mr. Tesla adds that he is finding increasing evidence to support the theory of moving material particles, and describes an experiment which he considers as positive proof that matter is expelled through the walls of the glass. In this experiment, if a small hole be made by the streamer produced by attaching a fairly-exhausted bulb to the terminal of a disruptive coil, air does not enter in at the opening; the interior pressure seems to be greater than the outside pressure of the atmosphere.

Another interesting observation made by Mr. Tesla is described by him.

"When working with highly-strained bulbs, I frequently experience a sudden, and sometimes even painful, shock in the eye. Such shocks may occur so often that the eye gets inflamed, and one can not be considered over-cautious, if he abstains from watching the bulb too closely. I see in these shocks a further evidence of larger particles being thrown off from the bulb."

Röntgen Rays in Sunlight.

We may be surrounded by elements and energies of whose existence we have at the present time not the slightest suspicion. Two discoveries announced within a twelvemonth sustain the belief in this possibility. The finding of argon, and the accidental discovery that the Röntgen rays (X rays) represent a form of energy differing in important respects from any other form of energy known to us, have now been followed by the no less important discovery that no artificial source is necessary to develop the irrefrangible X rays, and that they exist nominally in the radiant energies of the sun. This discovery is announced by Dr. Charles S. Dolley and Dr. Seneca Egbert, in a preliminary note contributed to *Science* (March 6), an abstract of which is presented below. A supplementary note by the editor of *Science* states that "results somewhat similar to those given by Drs. Dolley and Egbert have been announced by M. Gustave Le Bon, Prof. S. P. Thompson, and others. The conditions are, however, so complex that it is difficult to eliminate sources of energy other than the Röntgen rays. Careful experiments at Columbia College have not detected any penetration of ($\frac{1}{100}$ inch) sheets of aluminum by sunlight, though ebonite and wood of considerable thickness are penetrated by ordinary light."

In the preliminary note upon which the editor's note just quoted is a comment, the authors describe their discovery and the circumstances under which it was made.

"Dr. Egbert was led on February 22 to place in a photographer's printing frame an ordinary sensitive plate (Seed's No. 26), upon which was superimposed a positive lantern slide, and on this a shield of aluminum; which was then exposed to the direct rays of the sun for two hours, and the plate developed, when it was found that the aluminum shield had been transparent to some agent which had produced a photographic effect, although the sensitive plate was completely in the dark within the printing frame, and thoroughly protected from light rays as generally understood. Apparently, however, the plate had been over-exposed, and it seemed that better results might be obtained by shorter exposures. Therefore, other plates of the same kind were exposed by us for gradually decreasing periods, under negatives and positives, and shields respectively of aluminum, hard rubber, black cardboard and double thicknesses of opaque needle paper.

"Positives were obtained in each case resembling those obtained by the photographer with ordinary methods, in some cases the exposures being as brief as ten minutes.

"Shadowgraphs ('skotographs' or 'skiagraphs') were also produced by the methods employed by Prof. Röntgen, except that the source of energy was the direct sunlight in place of the rays from a vacuum tube,—*i. e.*, coins placed upon the aluminum shield produced shadow prints on the sensitive plate.

"It is obvious that these experiments prove the presence in sunlight of the peculiar rays described by Prof. Röntgen, or of others possessing the same properties,—namely, the power of penetrating substances opaque to ordinary light rays.

"Prof. Röntgen states, in the second clause of his article (as translated and printed in *Science* of February 14, p. 227,) 'that some agent is capable of penetrating black cardboard, which is quite opaque to ultra-violet light, sunlight, or arc-light.' If this statement refers to sunlight *in toto*, including the visible and invisible rays, it is evidently contravened by our experiments, which demonstrate beyond a doubt existence of an 'agent' in sunlight which accomplishes the work of the 'X rays.'

"Prof. Röntgen refers to the possibility that the effect is due to a fluorescence produced in the material of the sensitive plate. One of our experiments seemed to point to the correctness of this hypothesis. Fixed photographic prints on albumen paper placed between the aluminum shield and the sensitive plate gave corresponding negative effects; but the space covered by these prints was evidently more intensely acted upon by the rays than other parts of the plate covered only by the aluminum. Should fluorescence be produced by these rays in silver emulsions, it would perhaps explain the phenomena. Prof. Röntgen further states that silver in 'thin' layers allows the rays to pass; but we have shown that some of the rays are partially stopped by the exceedingly thin film of silver in the ordinary photographic negative.

"It is obvious that the discovery of these rays in sunlight opens up an entirely new field for experiment, and is of the highest practical importance to all photographers."

This discovery has immensely widened the field of possibilities, both scientific and practical. That we are on the eve of other great discoveries, which will be likely to subvert some current hypotheses, seems extremely probable. Expectancy is the present attitude of the scientific world.

A Curious Fabric Made by Insect Larvae.

ONE of the most remarkable products of insect life yet discovered is described by Professor W. G. Johnson in the *American Miller* (April 1). Specimens of this fabric were obtained by Professor Johnson from Dr. Trelease, of the Shaw School of Botany, in St. Louis, and photographed; half-tone pictures of them accompany his description of them. Dr. Trelease, in a letter quoted by Professor Johnson, says of these specimens that he obtained them from Dr. Francis Eschauzier, of San Luis Potosi, Mexico.

One of the specimens is described by Dr. Trelease as a " piece of thick, parchment-like substance nearly three feet square, cut from a piece over twenty yards wide and about four times as long, manufactured by a worm on the ceiling of a corn-storing loft. The specimen is nearly white, and has much the appearance and feeling of a soft-tanned piece of sheepskin, but is marked with brownish stripes. As a rule, the surface is as smooth as that of a piece of dressed leather, but here and there dingy, fluffy masses are found which are easily removed, leaving abraded, rough places. While, as a whole, the membrane is continuous from one side to the other, and of nearly uniform thickness, there are places where, as Dr. Eschauzier had observed before the sending the specimen to me, as many as four distinct and more or less separable layers are observable. Throughout the specimen is perforated by many round or elliptical holes, from the size of a pinhole up to nearly a half inch in diameter, many of them more or less occupied by the dingy, fluffy material already mentioned as occurring in places on the surface."

Dr. Trelease, writing to Professor Johnson, says:

" A year later Dr. Eschauzier sent me two additional pieces of similar material, but of a gray color and of extreme tenuity, like the first, perforated by frequent holes. These specimens are comparable with the loose material observed here and there on the first specimen, but in continuity and uniformity of thickness they resemble the larger piece. At first all of the specimens emitted a strong odor of flour, as was to be expected, considering their source. These curious pieces of tapestry are composed of myriads of fine silken threads crossing and recrossing at every conceivable angle, and so producing the seemingly homogeneous texture. Unfortunately Dr. Eschauzier has not yet succeeded in obtaining specimens of the creatures by which they are produced, but there is no doubt that they are the work of lepidopterous larvæ which feed upon grain, and the presumption is that they are made by the larvæ of what is called the Mediterranean flour moth (Ephestia kuehniella)."

Professor Johnson says this specimen is truly a remarkable texture. He thinks the thickness is made up of layers, each generation of insects adding one layer. He estimates that there are one hundred and fifty layers, and that, if it be supposed that six generations of insects are produced annually, the "tapestry" was the work of from twenty to twenty-five years. Another specimen is thin and delicate, probably the work of one or two years. Except its thinness, its characteristics are the same.

Professor Johnson does not accept the opinion that these tapestries are the work of the Mediterranean flour moth. He says:

" In the first place, I have never known of an instance where the flour moth attacked stored grain. It is primarily a mill pest, and is usually found in the manufactured products, and not in the whole grain. I have, with difficulty, colonized it in whole grain (corn) in my laboratory, while on the other hand I have no trouble in breeding it in meal and flour. Another point to be considered in this place is the fact that the larvæ of the flour moth begin spinning just as soon as they hatch from the eggs, and that they trail this waste silk through their food until they are full grown, when they migrate to some isolated corner for pupation. During their migratory period, however, little or no silk is trailed. If we stop to consider the fact that the tapestries in question are formed on the ceiling of the granaries, and that the corn is stored below, we are led to conclude that the fabric is the product of an insect that is a prolific spinner during its migratory period, and that it colonizes readily in stored grain.

" We have such an insect, and it is popularly called the Indian meal moth. (Plodia interpunctella). This little moth has a great variety of food products, and has a wide distribution. It is a serious pest to stored corn in many places, and has this year done much damage in stored grains in Central Illinois. When feeding in grain, the larvæ of this moth spin little, if any, silk during their growing period; but, when full grown, they leave their food, and crawl to some angle or corner, where they pupate. During this migratory period they spin very fine silken threads, wherever they go. Thus, when hundreds and thousands of the worms are crawling, a fine delicate fabric is soon constructed. I have a large colony of these creatures in my laboratory, and have repeatedly taken large pieces of silk of the finest texture from the tops of my breeding-cages. The sides of the cages are usually so thickly lined inside with this silk that I have some difficulty in seeing what is going on within. In my flour-moth cages I do not have any trouble, the silk being confined almost entirely to the flour or meal."

Cold Light.

UNDER this title, in *The Electrical World* (March 14), Mr. W. M. Stine discusses the economical transformation of energy into available power and cold light. This possibility has long been recognized, and much has been written upon it. Recently, however, the attention of the entire scientific world has been directed to the investigation of mysterious radiations whose existence, up to within a few months, has been barely more than suspected. A rapid accumulation of facts has resulted, and it seems as though a hitherto locked entrance to previously unknown avenues of research has been opened. To what discoveries this may lead no one can tell.

In animal organisms the fact that mechanical energy and light are produced by a consumption of substance almost incomparably less than has always been required for artificial power and illumination indicates that there are yet hidden methods of transforming energy of which we have not the slightest notion, except the one fact that they may exist. That in the researches into new forms of radiation we may stumble upon the key to these yet mysterious processes is a hope that renews interest in a somewhat hackneyed subject.

Touching the two surviving theories of light,—the electromagnetic, or ether-stress, and the mechanical, or ether-vibration, theories,—Mr. Stine says: "At present but one form of ether-wave has been positively proven to exist—the transverse. It was on this fact that the electromagnetic theory was based, and the unproven presence of longitudinal vibrations has been the most valid argument against the mechanical theory. Should investigations, now so universally carried on, prove with equal clearness the existence of longitudinal ether vibrations, the mathematical theory of light must needs be seriously modified, while the mechanical theory will be demonstrated beyond reasonable doubt. This matter has a most important bearing upon investigations on the production of cold light, since, if longitudinal vibrations exist, the ether must be considered granular, capable of at least minute condensation and rarefaction, and not as a perfectly rigid solid."

Mr. Stine expresses the belief that the artificial production of cold light will ultimately be reached, and intimates that the solution of the problem depends upon the discovery of means whereby a governable period can be given to molecular vibrations, and that the molecular vibrations must be established by direct means rather than by impact and direct collision. The only now-known direct means for transferring energy from a source to set up such vibrations are the electrical and magnetic methods.

Internal Temperature of the Earth's Crust.

A PRELIMINARY note of results of observations in the shaft of the Calumet and Hecla mine, by Professor Agassiz, who, aided by Mr. Preston C. F. West, engineer, has been taking observations at increasing depths reached in the mining operations, has been communicated to the *American Journal of Science*. He sums up the results as follows:

"We have, at the time of writing, attained at our deepest point a vertical depth of 4,712 feet, and have taken temperatures of the rock at 105 ft.; at the depth of the level of Lake Superior, 655 ft.; at that of the level of the sea, 1,257 ft.; at that of the deepest part of Lake Superior, 1,663 ft.; and at four additional stations, each respectively 550 ft., 561 ft., and 1,256 ft. below the preceding one, the deepest point being 4 580 ft.

"We propose, when we have reached our final depth, 4 900 ft., to take an additional rock temperature, and to then publish in full the details of our observations. In the meantime it may be interesting to give the results as they stand. The highest rock temperaure, obtained at a depth of 4,580 ft., was only 79° F.; the rock temperature at a depth of 105 ft. was 59° F, Taking that as the depth unaffected by local temperature variations, we have a column of 4,475 ft. of rock with a difference of temperature of 20° F., or an average increase of 1° F. for 223.7 ft. This is very different from any recorded observations; Lord Kelvin, if I am not mistaken. giving an increase of 1° F. for 51 ft., while the observations based on the temperature observations of the St. Gothard tunnel gave an increase of 1° F. for 60 ft. The calculations based upon the latter observations gave a thickness of the crust of the earth, in one case of about 20 miles, the other of 26.

"Taking our observations, the crust would be over 80 miles, and the thickness of the crust at the critical temperature of water would be over 31 miles, instead of about 7 and 8.5 miles as by the other and older ratios. With the ratio observed here, the temperature of a depth of 19 miles would only be about 470°,—a very different temperature from that obtained by the older ratios of over 2,000° F. The holes in which we placed slow registering Negretti and Zambra thermometers were drilled, slightly inclined upward, to a depth of 10 ft., from the face of the rock, and plugged with wood and clay. In these holes the thermometers were left from one to three months. The average annual temperature of the air is 48° F.; the temperature of the air at the bottom of the shaft was 72°."

Curious Experience with Röntgen Rays.

KNOWLEDGE (April 1) publishes the following communication from Leon J. Atkinson, Arthur H. Pook, and R. P. Williams:

"While carrying out experiments with Röntgen rays, we have obtained results which we consider worth further careful investigation.

"On exposing a plate contained in an ordinary card-board plate-box with the object of obtaining a shadowgraph of keys, coins, etc., on the top, we failed to obtain the usual image; on exposing another plate in the same box, after a trifling alteration of apparatus, but with an entirely different series of objects, we obtained, on development, a well-defined image of the objects first exposed. Struck with this phenomenon, we made another exposure in the same box with a plate from a fresh packet, and, on developing, obtained a good image of the objects placed for the *second* exposure. We have repeatedly obtained these remarkable results under the following varied conditions:

"Exposure made and no result; box left for two days; fresh exposure made with entirely different objects, and resulting negative clearly defined objects placed in the box two days before.

"Exposure made and box exposed to strong daylight, to ascertain if sunlight would discharge the latent image, but with no effect. After an interval of eight days, the box was again subjected to X rays, and a negative obtained of objects exposed eight days previously.

"This is at present entirely inexplicable, and, as we only seem to get these retained or latent impressions with one box, we have not yet subjected the cardboard of which it is composed to more than superficial examination. It is our intention to endeavor to obtain more boxes of this particular batch, and, if, with these, we can confirm our present results, we hope to elaborate a theory which will account for what we can only now term 'the storage and transformation of images formed by X rays in certain undetermined varieties of cardboard.'

THE ENGINEERING INDEX—1896.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Scientific and Engineering Journals—See Introductory.

4739. Tesla on Röntgen Rays. Nikola Tesla (Illustration of results in radiography at great distances through considerable thicknesses of substance, with an account of investigations by the writer). Elec Rev–March 11. 2500 w.

4741. Sciagraphic Experiments. W. M. Stine (An account of investigations directed towards the character of the new radiant). Elec Eng–March 11. 2500 w.

4742. Manifolding by Cathode Rays. Elihu Thomson (An experiment made to test the effect of Röntgen rays in producing simultaneously a number of impressions of the shadow of the same object. Illustrated description). Elec Eng–March 11. 400 w.

4743. Stereoscopic Roentgen Pictures. Elihu Thomson (The desirability of such pictures, especially in surgical examinations). Elec Eng–March 11. 500 w.

4744. Shadow Pictures from the Arc and Sunlight. Ill. W. H. Freedman (Tests made which show that shadow photographs obtained by means of the arc and sunlight are not X-ray pictures). Elec Eng-March 11. 500 w.

4745. Electric Images without Crookes Tubes. Ill. R. K. Duncan (Describes experiment). Elec Eng–March 11. 200 w.

4746. Ultra Violet Rays and Lamps Adapted to Produce Them. Herbert Cottrell (Conclusions of the writer as to construction, with directions). Elec Eng–March 11. 700 w.

4765. Recent Experiments in Scientific Kite Flying (Illustrated description of the Hargrave kite, Lamson's multiplane folding kite, and Lamson's modified Hargrave kite, with experimental use of these kites. Abstract of article in Aeronautical Annual for 1896). Sci Am–March 14. 1800 w.

*4771. In a Flour Testing Laboratory (Describes the laboratory and the means and methods in use for testing the quality of flour). Milling–Feb. 1700 w.

†4773. The Medical Aspect of the Nicaraguan Canal. E. R. Stitt (Abstract of report to Bureau of Medicine and Surgery, from Surgeon-General Lyon's Report to the Secretary of the Navy. 1895. Treats of the diseases to which unacclimated persons and natives are liable in the region, their causes and their prophylactic and remedial treatment). San–March. 6000 w.

†4786. Chemistry of the Berea Grit Petroleum. Charles F. Mabery and Orton C. Dunn (Besides a description of the results obtained by chemical analysis of petroleum, the region named and the geology of the oil-bearing strata is discussed). Am Chem Jour-March. 4800 w.

*4793. On the Chromogeneous Top. Charles Henry (An explanation of apparitions, produced by the rotation of the top and of the inversion of the order of their arrangement when the direction of rotation is reversed). Engng–March 6. 1000 w.

4804. Expe iments with Röntgen Rays. Alexander Macfarlane (Illustrated description of experiments made in the electrical laboratory of Lehigh University). Elec Wld-March 14. 1000 w.

4806. Cold Light. W. M. Stine (A consideration of the great waste of all forms of artificial illumination, and the problem of the controllable production of light. The writer considers the ultimate accomplishment almost a certainty). Elec Wld–March 14. 2500 w.

*4809. The X-Rays and the New Photography (A review of experiments and discoveries of various investigators in this field). Elec Rev, Lond–March 6. 2500 w.

*4810. The New Photography. Richard C. Shettle (An experiment which appears to determine that the cause of the phenomena which Prof. Röntgen was the first to discover, is the direct result of electric stress, and not as was supposed, of invisible light). Elec Rev, Lond–March 6. 900 w.

4821. Tesla's Latest Results in Radiography (Letter from Nikola Tesla. He now produces radiographs at a distance of more than forty feet). Elec Rev–March 18. 1300 w.

4822. Note on the Use of Acetylene Gas as an illuminant for Polariscope Work H. W. Wiley (Contributed by the Chemical Laboratory of the U. S. Dept. of Agriculture, to the Washington Section of the Amer. Chem. Soc). Pro Age–March 16. 800 w.

4825. An Acetylene Standard for Photometry (Translation of a paper by M. Violle in *Comptes Rendus*. Acelytene is considered as possessing certain advantages as a photometric standard). Pro Age–March 16. 500 w.

4826 An Inexpensive Photometer. *From Electrical Industries* (Illustrated description of a form of photometer, suggested by E. P. Roberts, which is cheap, and, it is claimed, gives satisfactory results). Pro Age–March 16. 900 w.

4827. The Manufacture of Cut Glass. Charles H. Garlic (Illustrated description). Safety V–March. 3000 w.

4831. Preparation of Lamb and Kid Skins for Gloves (Illustrated description of appliances and processes). Sci Am–March 21. 900 w.

4840. Röntgen Rays from the Anode Terminal. Elihu Thomson (Experiment showing that the rays proceed from the anode). Elec Eng–March 18. 700 w.

4844. Edison's Röntgen Rays Experiments. Edwin J. Houston and A. E. Kennelly (An interesting résumé of the result of Mr. Edison's experiments to date on Röntgen rays. The most notable conclusion reached is that there is no apparent advantage in obtaining a very high vacuum in the ray lamp and a criterion is given by means of which the proper degree of vacuum may be recognized). Elec Wld–March 21. 1300.

*4854. Engineers—Consulting, Inspecting, Contracting. George W. Dickie (Not an exhaustive treatment with respect to any of the points discussed, but intended rather to draw out a general expression from members of how these questions have affected them in their practice). Jour Assn Eng Soc-Feb. 7000 w.

4859. The Use of Logarithms. C. K. Jackson (Gives instructions in the use and application of logarithms in abbreviating arithemetical and algebraic operations). Am Mach-March 19. Serial. 1st part. 1500 w.

†4928. Facts and Figures Regarding Our Forest Resources Briefly Stated. B. E. Fernow (Forest area, character of forest growth, amount of standing timber ready for cutting, value, exports, imports, uses of timber in the arts, centers of production and many other interesting topics are treated in this circular). U S Dept of Agriculture Circ No 11. 3500 w.

*4940. The New X-Ray "Focus" Tube (Illustrated description of a tube for producing X-rays which is said to be a great improvement on anything in this line that has been previously produced). Elec Rev, Lond-March 13, 700 w.

*4941. Electricity a Mode of Motion.—The Röntgen Rays. What Are They? Sydney F Walker (The writer considers the Röntgen rays to be electrical waves under very high tension, and their action is due to their conversion into light waves, etc). Elec Eng, Lond-March 13. 1300 w.

*4950. The Tobacco Industry of India and the Far East. C. Tripp (The conditions necessary for the production of high class tobacco are considered, and the special conditions of the regions named. The paper is followed by a discussion). Jour Soc of Arts-March 13. 14000 w.

*4951. The New Photography by Cathode Rays. John Trowbridge (Illustrated description in popular style. Gives application of the new photography to surgery, by a method of locating the exact position and depth of a bullet by triangulation). Scrib Mag-April. 2400 w.

4953. Experiments with Roentgen Rays. Thomas A. Edison (Investigations on fluorescing salts, and experiments with vacuum tubes). Elec Eng-March 25. 600 w.

4954. Roentgen Rays "Anodic" not "Cathodic." Elihu Thomson (Experiments made by the writer to determine whether the rays are emitted from the cathode or anode). Elec Eng-March 25. 1300 w.

4955. The Spectra of the Bunsen Burner and Exhausted Bulbs. W. H. Birchmore (Interesting investigations of light). Elec Eng-March 25. 2300 w.

4956. Shadow Pictures by Arc Light Rays. W. W. Ker (Experiments made which add a few facts concerning the production of X-rays). Elec Eng-March 25. 700 w.

4958. Roentgen Rays. Max Osterberg (Abstract of a lecture delivered before the New York Elec Soc). Elec Eng-March 25. 2800 w.

4964. On the Generation of Longitudinal Waves in Ether. Lord Kelvin (Paper read before the Royal Society. Showing an arrangement by which a large space of air is traversed by waves essentially longitudinal). Elec-March 25. 1200 w.

*4975. The Cathode Ray,—Its Character and Effects. A. W. Wright (Historical sketch of the steps leading up to the discovery of the cathode ray, and a general summary of the present state of knowledge with respect to its nature). Forum-April. 2200 w.

4995. State Engineering Experiment Stations. J. P. Jackson (Explains the provisions of a bill now before Congress, having for its object the promotion by annual grants of money from the national treasury, of scientific investigation, engineering research and experimental testing at the various State colleges which are beneficiaries of the Land Grant Act of 1862). Elec Wld-March 28. 1100 w.

4998. Theories of the Röntgen Rays. W. M. Stine (The hypotheses of the nature of the rays already advanced, and pointing out fallacies). Elec Wld-March 28. 1200 w.

4999. The New Marvel in Photography. Ill. H. J. W. Dam (A visit to Prof. Röntgen at his laboratory in Würzburg. His own account of his great discovery. Interesting experiments with the cathode rays. Practical uses of the new photography). McClure's Mag-April. 4800 w.

5000. The Röntgen Rays in America. Cleveland Moffett (A review of work by Arthur W. Wright, William J. Morton, W. L. Robb, M. I. Pupin, Thomas A. Edison, etc., with illustrations). McClure's Mag-April. 3300 w.

5001. Sciagraph of Sheep's Brain (Experiments of John Kammer of Chicago are described). W Elec-March 28. 500 w.

5006. On the Reflection of the Röntgen Rays from Platinum. Ogden N. Rood (Describes experiments made by writer). Science-March 27. 700 w.

5007. Further Experiments with X-Rays. Edwin B. Frost (Experiments made at the Dartmouth Laboratory). Science-March 27. 1300 w.

*5010. The New Photography. Charles Barnard (Popular explanation aiming to show the value and import of Prof Röntgen's discoveries). Chau-April. 3000 w.

*5032. The Sisal Industry in the Bahamas. D. Morris (A very full account of the entire industry, including a botanical description of the plant, methods of extracting the fibre, etc., with discussion). Jour of Soc of Arts. March 20. 10000 w.

†5061. The Röntgen Rays. Edwin J. Houston and A. E. Kennelly (This paper gives a résumé of facts known concerning Röntgen's discovery, and some of the theoretical explanations of the X rays that have been offered. The discussion following the reading of the paper is of much more than usual interest, having been participated in by many learned scientists, and presenting some facts of personal experience, that have not hitherto been generally known). Jour Fr Inst-April. 14500 w.

†5070. The Practical Results of Bacteriological Researches. George M. Sternberg (Address of the president of the Biological Society of Washington, delivered Dec. 14, 1895, under the auspices of the joint Commission of the Scientific Societies of Washington. A résumé of progress in bacterial research from its beginning down to present date). Pop Sci M–April. 6500 w.

†5071. The X-Rays. John Trowbridge (A general dissertation in which the author is forced to conclude that in this phenomenon we are brought closer to a wave theory in a medium han in a molecular theory of movement of matter). Pop Sci M–April. 2300 w.

5087. The Manufacture of Paper (Description of materials and processes employed in paper manufacture). Sci Am–April 4. 1500 w.

5089 The Edison X-Ray Experiments, Apparatus and Fluoroscope (Illustrated description indicating mode of application to surgical examinations). Sci Am–April 4. 1100 w.

5091. Röntgen's Rays (A collection of opinions, experiments, explanations, and experiences of eminent scientists, given under various headings). Sci Am Sup–April 4.5400 w.

5092. Acelytene Apparatus. T. O'Conor Sloane (Illustrated detailed description of apparatus and method of using it). Sci Am Sup–April 4. 2800 w.

5093. The Porcelain Works at Meissen (An exceedingly interesting description, with excellent and numerous illustrations of processes in various stages). Sci Am Sup–April 4. 2200 w.

*5108. Metric System of Measurements Demanded (An argument against the adoption of the metric system in the United States. It is alleged that its advocates are mostly college teachers and enthusiasts who do not realize at what cost a change of measurements would be effected). Loc Engng–April. 1800 w.

5112. Opaque Objects Made Transparent by Rays Passing through Chemical Solutions (An account of an alleged remarkable discovery, by Mr. A. G. Davis. of Parkersburg, consisting of an arrangement of chemical solutions, the effect of which is to make opaque bodies transparent to light). Elec Eng–April 1. 500 w.

5115. On the Sensitiveness of Certain Salts to the X Rays. Thomas A. Edison (Brief description of the writer's recent researches on the fluorescence of metallic salts). Elec Rev–April 1. 500 w.

5116. Edison's Fluoroscope (Illustrated description of a device that promises to be of great value to the medical profession). Elec Rev–April 1. 600 w.

5117. Tesla on Reflected Roentgen Rays (A communication from Nikola Tesla regarding results obtained by means of his apparatus, giving tests and investigations of the reflective power of conductors). Elec Rev–April 1. 3000 w.

5136. Statues and Monuments of New York. N. Macdonald (A critical description of the statues erected in New York, with names of artists and points of interest regarding them). Arch & Build–April 4. Serial. 1st part. 2500 w.

5140. Electrographs. Walter H. Merrill (Illustrated account of experiments tending to show that good results can be obtained by using the electricity obtained from a charged driving belt, or any similar source, provided the connections are properly made). Elec Wld–April 4. 600 w.

5142. The Surgical Value of the X-Ray. James Burry (A consideration of the Röntgen rays only from the surgeon's point of view). W Elec–April 4. 1400 w.

5143. On the Source of the Röntgen Ray. W. M. Stine (Experiments which the writer claims show that there is but one marked source of the ray, that portion of the bulb opposite the cathode, and that the entire surface of the bulb is more or less a weak secondary force). W Elec–April 4. 1100 w.

5144. The Source of the X-Ray. C. E. Scribner and F. R. McBerty (Experiments with pin hole images seeming to prove that the rays proceeded only from the bombarded spot at the inner wall of the tube opposite the cathode). W Elec–April 4. 1800 w.

5150. Directory of Engineering Societies (Gives not only names and addresses but also places and dates of meetings and names of secretaries for all engineering societies in the United States and Canada). Power–April. 3700 w.

†5166. A Theory of the "X-Rays." Albert A. Michelson (The theory of longitudinal waves, and theory of projected particles, are enunciated and their difficulties stated. The author then presents a third theory which he calls the "ether-vortex" theory, by which he seeks to explain the production of the rays by electric impulse at the cathode, in a highly exhausted enclosure; the propagation of the rays in straight lines; absence of interference, reflection, refraction and polarization; the importance of the density of the medium, as the determining factor in transmission of the rays; the production of fluorescence and actinic effects, and the action of the rays on electrified conductors. In this theory the X rays are considered as vortices of an intermolecular medium). Am Jour of Sci–April. 1000 w.

†5167. The Variation of the Modulus of Elasticity with Change of Temperature as Determined by the Transverse Vibration of Bars at Various Temperatures. The Acoustical Properties of Aluminum. Alfred M. Mayer (Read before the British Association, at Oxford. An important and laborious research is described, which is accompanied by extensive tables of data. Many diagrams, illustrating by the graphic method variations of the modulus of elasticity at various temperatures, etc., and engravings, illustrating descriptions of apparatus and methods). Stev's In–April. 6000 w.

†5169. Roentgen Rays. Henry Morton (States facts which explain the true character of Röntgen's discovery and the mixed or uncertain character of many experiments recently made by others. Prof. Morton says that many experimenters who have been producing shadowgraphs

with sunlight, electric lights, and the like have not been repeating Röntgen's operations but only applying facts known for fifteen years or more). Stev's In-April. 2400 w.

†5170. Heating Value of the Volatile Portion of Bituminous Coal. William Kent (Suggestions to any one who may be disposed to undertake a research of this kind. The research will involve much labor but will supply answers to the following questions. (a) What is the character of the volatile matter of the more highly bituminous coals? (b) May it not be commercially possible to get rid of the least valuable products at the mines by some kind of coking process?). Steven's In-April. 1600 w.

†5172. Practical Photometry. Alten S. Miller (The Bunsen photometer is illustrated and described and a mode of using it effectively is set forth). Steven's In-April. 2800 w.

†5173. Novel Experiments with X-Rays. Edward P. Thompson (Successful experiments directed to the determination of the possibility of applying X-rays to the discovery of movements of hidden objects). Steven's In-April. 900 w.

*5174. Silk Fabric Made by Insect Larvæ. W. G. Johnson (Describes and illustrates a most remarkable fabric made by an insect not yet determined, one of the specimens being a piece about three feet square, cut from a piece twenty yards wide and nearly four times as long, manufactured on the ceiling of a corn-storing loft). Am Miller-April. 1600 w.

*5175. Fires in Flour Mills During 1895 Despite the favoring conditions resulting from depression in trade, which increases the moral hazard, these statistics show no material increase in mill fires for the year. A table of fires for 1894 and 1895 is presented, with other interesting details). Am Miller-April. 1600 w.

5188. Brickmaking in Tuskegee, Ala., Industrial School. Victoria Earle Matthews (Illustrated description of the industry and some of the buildings erected with these bricks). Brick-April. 1200 w.

*5191. The Classification of Physical Experiments. E. E. Fournier-D'Albe (The object of the paper is to specify the characteristic types of experimental elements, and to find a simple and comprehensive classification and notation for the various physical experiments). Elect'n-March 27. 2200 w.

*5200. How to Photograph and See Through Opaque Bodies. E. Andreoli (Illustrated description of apparatus recommended by Messrs. Ducretet and Lejeune whereby electrical students, medical men, etc., can produce X-rays without the installation of an alternator, &c.) Elec Rev, Lond-March 27. 1100 w.

5202. Professor Enrico Salvioni's Work on the X-Ray. Salvatore Cortesi (An interview with this eminent scientific man at the University of Perugia, Italy). Elec Rev-April 8. 2500 w.

5203. Tesla on Roentgen Radiations (An account of recent work accomplished. The time is reduced and the distance is four feet). Elec Rev-April 8. 2000 w.

5206. Are Roentgen Ray Phenomena Due to Sound Waves? Thomas A. Edison (An account of experiments with comments, and a reproduction of the article referred to). Elec Eng-April 8. 1300 w.

5207. The Roentgen Ray Source. Elihu Thomson (Correcting the statement made by the writer that the anode was the source of the rays). Elec Eng-April 8. 700 w.

5208. I. Centralizing X-Ray Bulb. II. External Electrodes Vacuum Bulb. III. William James Morton (Experiments explained). Elec Eng-April 8. 800 w.

5209. Phosphorescence as the Source of X-Rays. Edward P. Thompson (Experiments that give substantial evidence that X-rays are not obtained from phosphorescence by sunlight). Elec Eng-April 8. 1700 w.

5211. M. de Morgan's Discoveries at Dahshur. (Illustrated description, reprinted from *Illustrated London News*. The specimens of ancient Egyptian gold-smith work illustrated are a most interesting addition to specimens of ancient handiwork and to the history of ancient art). Sci Am Sup-April 11. 1900 w.

5212. Intermittent Springs. Walter C. Garretson. (A new theory, which the writer thinks confirmed by experiments which he describes). Sci Am. Sup-April 11. 1200 w.

5213. Increase of the Photographic Yield of the Roentgen Rays by Means of Phosphorescent Zinc Sulphide. Charles Henry. (Describes experiment proving that by coating with phosphorescent zinc sulphide bodies capable of absorbing Röntgen rays, it is possible to render visible on the photographic plate, objects situated behind such bodies, and otherwise invisible). Sci Am Sup-April 11. 1100 w.

5214. On a Mechanical Action Emanating from the Crookes Tube Analogous to the Photographic Action Discovered by Roentgen. Messrs. Gossart and Chevalier. (Note communicated to *Comptes Rendus*. The view is expressed that this may be a point of departure for a series of researches which the writers hope to pursue—the study of the field of the Crookes tube with the radiometer). Sci Am Sup-April 11. 800 w.

†5226. Rivers of the South American Rubber Country. Hawthorne Hill. (An account of the badly obstructed rivers of this region, and the benefits to trade—especially in crude india-rubber—that would follow the overcoming of these difficulties in transportation). Ind Rub Wld-April 10. 1000 w.

†5227. Condition of the Rubber Trade in Chicago. (An interesting letter on the growth and prosperity of this industry). Ind Rub Wld-April 10. 2500 w.

†5228. Changes in the New York Rubber District. (Review of interesting history of some of the large rubber houses, with notices of removals to larger and better quarters). Ind Rub Wld-April 10. 1000 w.

†5229. Single-Tube Tires and the Tillinghast Patents (An article of interest to bicycle manufacturers. A review of the whole subject). Ind Rub Wld-April 10. 2200 w.

COMMENT & CRITICISM

The Engineering Index.

I NOTED your adverse comments last fall, on a suggestion made by one of your readers, that the index to current engineering literature be printed on one side of the sheet only, and placed in the back of the volume. It may be quite true that the number who would now make use of the same for card-indexing is limited, but the fact remains that there is an increasing demand for means of reference to the scattered articles on engineering subjects, to which fact your very complete index bears ample testimony.

Might I suggest that the index be printed among the advertising pages, using one side of the page for advertising matter, and the other for the index, in the same style as formerly followed by the *Journal of the Association of Engineering Societies*, but with the improvement of having the articles classified. I see no reason why this should incur additional expense in publication, while it should increase the value of the advertisements. In this form, your readers could detach the pages without mutilating the magazine, and could mount them on the card index, or classify them by any desired method.

As at present arranged, the index appeals to me as an exceedingly valuable feature of your publication; but I sincerely trust that some alteration can be made, whereby your readers may be enabled to arrange the sheets, so as to give them a permanent instead of a passing value.

ARTHUR S. TUTTLE.

Brooklyn, April, 1896.

[AN insuperable objection to Mr. Tuttle's suggestion is the obvious fact that such an arrangement would give our pages the unmistakable appearance of an advertising sheet. The practice of interlarding advertisements with reading matter, and the wholesale insertion of "write-up" matter in the editorial pages of industrial journals, may be fitly described as a nuisance. Engineering journalism can never hope to attain that degree of potent influence and material prosperity which is possible, until every taint of advertising is rigidly excluded from editorial pages.

Mr. Tuttle, and doubtless many others of our readers, will be gratified to learn, however, that it is a part of our plan to reissue our monthly index in the form of a regular annual volume. The aim will be to have it cover the entire range of English and American engineering literature, for each calendar year from January to December, and to have the work so thoroughly classified and so conveniently arranged that it may serve as a complete and ready reference to everything of value published during the year. In short, the idea will be to issue such a volume as will remove the necessity for card indexes of all kinds.

Volume II of THE ENGINEERING INDEX, covering the four years to January 1, 1896, will be issued this month, thus completing the splendid work which the Association of Engineering Societies has carried on for the past eleven years. We shall now take up the work where they left off, and the annual volumes will appear regularly, as above mentioned.—THE EDITOR.]

Fires From Steam Pipes.

I NOTICE in the December number of THE ENGINEERING MAGAZINE some instances of danger from steam-heating apparatus.

I want to add two cases which occurred in Washington, and within my own knowledge. One was the Corcoran building, opposite the Treasury, which took fire from the steam pipes at night; the fire was discovered and extinguished before any serious damage occurred. The other was a private dwelling near my own. In this a low-pressure steam-heating apparatus had been placed but a few weeks before. The boiler was set in a room a little lower than the other rooms of the basement, and one steam supply pipe and two return pipes were run alongside of each other under the floor of the adjoining room, on the ground. The floor took fire where these pipes were assembled, and the flames came near destroying the house. That very season, a party engaged in putting in steam-heating apparatus here was stating in the papers that it was impossible to set wood on fire by steam pipes.

There is no question that steam-pipes generate fire in wood under suitable conditions, whether they are covered or exposed, especially when situated where lint and dust will accumulate upon them. In the case of wood and similar material, the wood in the course of time becomes charred, and ultimately takes fire, like charcoal. Too much care cannot be taken to prevent this. Much better have the pipes exposed than cover them, unless with incombustible material; and in no case should they be run in contact with joists, flooring, or any wood work without thorough protection. Now that steam heating is becoming so common, even in private residences, this matter deserves careful attention. W. C. DODGE.

Washington, April, 1896.

Telephones for Trolley Cars.

IN your February issue, page 943, you refer to an installation of telephones on a line of street railway. About the same time the writer was experimenting with telephones, and he has now equipped the Bangor, Orono, and Old Town Railway with a system which we consider far superior. We run an iron wire by the side of the trolley over all the road; where bracket work is used, the wire is on the poles. The telephone is on the car in a small box. When delayed, the conductor swings the trolley-pole to the iron wire, and, by pressing a key, calls the office for instructions. You can readily see the advantage of such a system over the one mentioned in the article referred to. This line is in daily operation. I. L. MELOON, Supt.

Bangor, Me., April, 1896.

Due Credit to Mr. Grimshaw.

REFERRING to the statement of Mr. Outerbridge in the December issue of THE ENGINEERING MAGAZINE, that the mechanical handiwork schools of the Spring Garden Institute, Philadelphia, were established (soon after the famous Russian exhibit at the Centennial Exposition) under the supervision of Lieut. Crawford of the Navy, Mr. Addison B. Burk, president of the Institute in question, states that they were established in the fall of 1879 by Dr. Robert Grimshaw; that the first class was organized January 26, 1880; and that Lieut. Crawford, being detailed to the Institute in the fall of 1882, reorganized the classes. RECORD.

Philadelphia, March, 1896.

Mr. Atkinson and His Critics.

I AM very much gratified by the newspaper slips that you have sent me, especially the abusive comments, from some of the silver States, upon my recent article on "Jingoism."

I am reminded of a previous experience of this kind. Either by the error of my stenographer, or that of a printer's devil on one of the western papers to which I sent a letter, two dates affecting the silver question were transposed, and I therefore appeared to state what was not true historically. Upon this, the editor of the Denver *Republican* wrote and sent me a marked editorial to this effect: "Edward Atkinson is the champion liar of the world—the most accomplished one that ever lived. Ananias was very discreet in getting himself born early in history, for, if he had waited until now, he would have had no reputation compared to Atkinson." To this I replied by letter, which, of course, was not printed, somewhat in these words: "I value such editorials as that you have kindly sent me. They always go into my scrap-book, because they prove that I have hit the mark. My rule in discussing free coinage is, wherever I see a silver head, hit it; and I am rejoiced to have the evidence in this case that I have cracked a skull empty of everything except courtesy."

EDWARD ATKINSON.

Boston, March, 1896.

Steam Boiler Efficiency.

PLEASE allow me to offer the following in regard to your review, on p. 759 of your January number, of an article by Mr. Westerbaan Museiling on steam boiler efficiency in *Engineering* (Nov. 1):

Let g=sq. ft. of grate surface in any boiler
h= " " " heating surface
c=pounds of coal burned per hour
w= " " water evaporated per hour

then $\frac{c}{g}$=pounds of coal per sq. ft. of grate surface per hour (*a*)

$\frac{w}{c}$=pounds of water per pound of coal (*d*)

$\frac{h}{g}$=sq. ft. of heating surface pei sq. ft. of grate surface (*b*)

$\frac{w}{h}$=pounds of water per hour per sq. ft. of heating surface (*c*)

then, according to the rule given,

$$a.d=b.c$$

or, using our equivalents,

$$\frac{c}{g}.\frac{w}{c}=\frac{h}{g}.\frac{w}{h}$$

and, cancelling like factors in numerators and denominators,

$$\frac{w}{g}=\frac{w}{g}$$

Of course it does; and you will see that, as each quantity is used twice in such a way that it neutralizes itself, any or all of them might be wrong to any extent without affecting the equality.

In the light of the above, I would like to ask you why you consider the agreement in these various tests so surprisingly close. What have the inaccuracies to do with experimental errors? Would it not be as pertinent to prove experimentally that, because twice three is six, one-half of six will be three in the generality of cases?

GEO. H. TABER, JR.

New York, March 23, 1896.

[This application of the Heuett's chain rule was similarly criticised in *Engineering*, subsequent to its publication. Our tacit approval of its usefulness in the review referred to was due to great confidence in the source from which the article was selected. This led to its publication without a critical examination, which would have shown the weakness plainly indicated in Mr. Taber's criticism.—EDITOR.]

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

S. Wilks Manufacturing Co., Chicago, Ill., U. S. A. = Catalogue. Illustrating and describing a remarkably fine line of hot-water heaters, steam generators, steam tanks, etc., for hotels, dwellings, greenhouses, laundries, churches and baptisteries, bath houses, carriage houses, etc., etc. This line of goods represents a great variety of high-class heating appliances, constructed of steel and adapted to numerous purposes in domestic engineering.

Buffalo Forge Co., Buffalo, N. Y., U. S. A. = Illustrated Sectional Catalogue of the Buffalo Horizontal and Upright Engines. Including in descriptions side-crank and self-contained horizontals with throttling governors, center-crank automatic cut-off horizontals, double and single automatic cut-off uprights, etc., for electric lighting and general refined service. First catalogue issued by this company devoted entirely to engines, and is presented in the elegant form characteristic of all its trade publications.

The Fairbanks Co., New York, U. S. A. = Illustrated Catalogue and Price-List of hand, platform, and dry goods trucks, and express and baggage barrows.

Royal Electric Co., Peoria, Ill., U. S. A. = Illustrated Catalogue of Electrical Machinery for light and power.

Merchant & Co., Incorporated, Philadelphia, New York, and Chicago, U. S. A. = Pamphlet entitled "Overhead." Describes and illustrates artistic metal roofing with engravings of important buildings upon which such roofing has been placed.

The Jeffrey Manufacturing Co., Columbus, Ohio, U. S. A. = Catalogue, No. 43. Describes and illustrates chain belting, elevators, conveyors, carriers, power-transmission machinery, etc.

The John F. Byers Machine Co., Ravenna, Ohio, U. S. A. = Catalogue. Illustrates and describes latest and best style of hoisting machinery, including hoisting engines, boilers, derrick irons, hand powers and elevators, and a line of contractors' and builders' supplies.

Boston Belting Co., Boston and New York, U. S. A. = (*a*) Catalogue illustrating and describing a complete line of garden hose, and hose appliances for gardeners' use. (*b*) Catalogue and price list of fire hose, and hose appliances, test pumps, hose racks, couplings, etc.

Translucent Fabric Co., Quincy, Mass., U. S. A. = Pamphlet entitled "Translucent Fabric," describing the flexible, durable, and unbreakable substitute for glass manufactured by this company for skylights, office doors, and all purposes where glass is likely to be broken. These various applications are explained, with the aid of engravings, in a very concise and clear way.

American Blower Co., Successor to Huyett & Smith Mfg. Co., Detroit, Mich., U. S. A. = Pamphlet entitled "Speaking About Bricks," illustrating the "A B C" progressive brick dryer for drying brick, tile, terra cotta, etc. The subject of brick drying is treated scientifically and practically in this well-written and interesting pamphlet, which also contains testimonials from users warmly commending the apparatus.

Lidgerwood Manufacturing Co , New York, Boston, and Chicago, U. S. A. = Large pamphlet illustrating and describing hoisting and conveying devices. The engravings are very numerous and well-executed, and illustrate examples of apparatus in use at many places, and for a variety of work.

J. S. Mundy, Newark, N. J., U. S. A. = Pocket Catalogue of high-class hoisting, bridge erecting, pile-driving, bogging, mining, and quarry machinery, mud dredging engines, steam boilers, etc.

Otto Goetze, representative in the United States of Ed. Muller & Mann, Charlottenburg, Germany. = Pamphlet describing "Manocitin" for protecting iron and steel from rust, and preventing corrosion and rust upon anything liable to be injured in this way when exposed to atmospheric influences.

Milne Manufacturing Co., Monmouth, Ills., U. S. A. = Catalogue illustrating and describing grub and stump machines, and other appliances for clearing timber land.

Lidgerwood Manufacturing Co., New York, Boston, Chicago, U. S. A. = Pamphlet beautifully illustrated in half-tone entitled "Logging by Steam." Describes improved systems under the patents of Butters, Baptist, Beekman, Miller, and Dickinson.

Link-Belt Engineering Co., Philadelphia and New York, U. S. A. = Elegantly printed and illustrated catalogue, describing modern methods of mining, and handling coal, minerals, etc.

American Injector Co., Detroit, Mich., U. S. A. = Catalogue for 1896. Illustrates and describes a line of injectors, ejectors, jet-pumps, drive-well jet-pumps, exhaust injectors, fire plugs, grease-cups, etc.; also contains data useful to engineers.

American Boiler Co , New York, Chicago, U. S. A. = Elegantly printed and illustrated catalogue describing the "Florida" hot water and steam heating boilers, and hot water and steam heating apparatus, with lists of sizes, capacities, etc.

William Sellers & Co., Philadelphia, Pa., U. S. A. = Leaflet, illustrating and describing new centrifugal sand-mixing machine, the method of using it, and its great advantages.

The Q & C Co., Chicago, Ill., New York, N. Y., Atlanta, Ga., Boston, Mass., St. Paul, Minn., U. S. A.=Leaflet entitled "Extract from the Engineering Magazine,"—a plain, pointed, and practical statement of the usefulness in shops of this excellent device.

National Pipe Bending Co., New Haven, Conn., U. S. A.=Pamphlet illustrating and describing the "National" feed-water heater, with details and dimensions, method of setting, table of percentage of fuel saved by its use, etc.

Ross & Co., London, Eng.=Abridged price list of articles for photo outfits.

H. W. Johns Manufacturing Co., New York. =Pamphlet entitled "Atlanta Exposition Locomotive Exhibits." Examples of locomotive boilers lagged with the asbestos cement manufactured by this firm.

General Fire Extinguisher Company, Providence, R. I., U. S. A.=United States Sprinkler Bulletin, January 31, 1896. A quarterly trade publication issued by this company, which sets forth the advantages of fire-extinguishing devices, instances where they have been effective in putting out fires, and general information relating to fires.

The Watson and Stillman Hydraulic Machinery Works, New York, U. S. A.=Catalogue of hydraulic jacks, hydraulic presses, pumps, valves, gages and fittings, punches, shears, etc., with illustrations, directions for use, price lists, etc.

Lidgerwood Manufacturing Company, New York, Chicago, and Boston, U. S. A.=Pamphlet, 72 pages. Elegantly illustrated in half-tone. "Contractors' Methods Employed on the Great Chicago Drainage Canal." A most interesting and instructive compilation, incidentally illustrating the uses and advantages of the traveling cableways manufactured by this company. A model trade publication.

Jones and Lamson Machine Co., Springfield, Vt., U, S A.=Pamphlet, 79 pp. (with large infolding plate), entitled "Rapid Lathe Work." Describes and illustrates in detail the "Hartness," a flat turret lathe, gives a list of 350 of these machines in use in large establishments, and is altogether a very fine trade publication. The infolding plate shows samples of work done on this lathe, and gives brief descriptions of the methods for producing them.

T. H. McAllister, New York, U. S. A.= Condensed list of optical goods.

Buffalo Forge Co., Buffalo, N. Y., U. S. A.= (a) Leaflets describing and illustrating "Buffalo" blacksmiths' drills Nos. 60, 66 and 68, and other blacksmiths' tools and appliances. (b) Leaflet describing and illustrating a new "Buffalo" steel plate bellows forge for bridge-builders, boiler makers, and structural iron workers.

Fraser & Chalmers, New York, U. S. A., Denver, Colorado, U. S. A., Chicago, U. S. A., Salt Lake City, Utah, U. S. A., and London, Eng.=Catalogue, 180 pp., illustrating and describing a long line of gold and silver mills, and other metallurgical machinery and apparatus. An admirable work of very great value to every one concerned with modern and economic mining operations.

F. Weber & Co., Philadelphia, Pa.=Catalogue of Architects, Engineers, and Draughtsmen's Supplies.

The New Britain Machine Co., New Britain, Conn., U. S. A.=Illustrates and describes chain-saw mortisers and the Case steam engines manufactured by this company.

The Colorado Iron Works, Denver, Colorado, U. S. A.=Pamphlet, containing important information relating to ore-crushing machinery for concentration, amalgamation, cyanide and chlorination plants.

Diamond Machine Company, Providence, R. I., U. S. A.=Catalogne of Diamond Grinding Machinery for all Metals, with index to other catalogues illustrating and describing lines of grinding machines for a great variety of special purposes.

Beaman & Smith, Providence, R. I.=Catalogue of machine tools, special machinery, etc.

Staples, George S. Annual Report of the Commissioner of Streets of Portland, Me. Williams M. Marks, printer, Portland, Me. 1895.

Fernald, George N. Annual Report of the City Engineer of Portland, Me. William M. Marks, printer. Portland, Me. 1895.

Preston, Ed. B., M. E. California Gold Mill Practices. California State Mining Bureau. San Francisco. 1895.

Poor, H. V. Directory of Railway Officials. Tenth Annual Number. H. V. & H. W. Poor, N. Y. 95. Cloth. $3.

Foster Engineering Co., Newark, N. J., U, S. A.=Catalogue, 16 pp., illustrating and describing "New Class W" pressure regulators. reducing valves and pump governors for regulating pressures of steam, water, gas, or air.

The Electric Storage Battery Co., Philadelphia, Pa., U. S. A.=Pamphlet, 52 pp., illustrating and describing the "Chloride Accumulator."

Flush Tank Co., Chicago, Ill., U. S. A.=(*a*) Catalogue of Sewer Siphons. (*b*) Pamphlet illustrating and describing siphon eduction range water closets for schools, factories, and public buildings.

P. F. Olds & Son, Lansing, Mich., U. S. A. =Catalogue. Illustrates and describes gas- and gasoline-engines.

Rue Manufacturing Co., Philadelphia, Pa., U. S. A.=Catalogue B. Illustrates and describes, with price lists, a line of "Little Giant," "Fixed Nozzle," and "Unique" injectors.

Knowles Steam Pump Works, New York, Boston, Chicago, U. S. A., and London, Eng. =Special Catalogue, illustrating and describing electric power pumps.

The Waterbury Farrel Foundry and Machine Co., Waterbury, Conn., U. S. A.=Catalogue, 318 pages, in book form, illustrating and describing an extensive line of machine tools, machinery, and appliances.

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THE FRUITS OF FRAUDULENT RAILROAD MANAGEMENT.

By J. Selwin Tait.

IN the case of municipal mismanagement and corruption a country's "dirty linen" can be washed at home, and the world at large not be made unpleasantly aware of the process or the need thereof. In the improper handling of its finances, however, that is, of securities which have an international importance, its "dirty linen" is washed in the thronging centres of every great monetary nation, to the mortification, discredit, and loss of the country of issue.

Thanks to its enormous natural advantages, the United States is to-day the richest country in the world, and this while its resources are not half developed. Under ordinary conditions, the disparity between its wealth and that of the richest of European countries must become more and more conspicuous, because the natural wealth of Europe has already been realized and added to its available assets, while this country is still largely undeveloped, and a great appreciation in its wealth is inevitable.

Here, then, we have a condition of affairs which ought to place our government securities, our railway stocks and bonds, and all our investment stocks at the head of every competing security in the world, and American investments ought, without effort and simply by the natural process of rising to their proper level, to be more in demand than those of any other country. Such is the heritage which the youthful financier, or investor, should feel to be his own on entering Wall Street for the first time; yet what does he find? Well, suppose he takes up a copy of the latest London *Statist*, one of the two principal financial papers of the greatest investment city in the world, and a paper which does much in moulding public opinion, he reads:

The Baltimore default heightens the existing distrust by investors of American securities. Investors have no safeguard that the financial position of any company is what its reports state it to be. . . . We cannot but reiterate our advice to the British public not to take any interest whatever in the American share market.

This may seem a somewhat harsh and sweeping judgment, when we call to mind some of our really high-class American railway stocks; but, as Matthew Marshall points out in a recent article in the *Sun*:

Time was when Baltimore & Ohio stock paid regular dividends of ten per cent. per annum and stood at 191 per $100 share. That in the short space of ten years it should have fallen to where it is now cannot but make the holders of New York Central, Boston & Albany, New York & New Haven, Pennsylvania, and similar first-class stocks pause and consider whether they too may not, in the course of ten years or so, not only see their dividends disappear, but be called upon to put their hands in their pockets for contributions to rescue the shattered remnants of their property from complete destruction. Such a view is illogical, but it is natural.

And this is where one of the very worst effects of the engendered distrust appears. It is like an outbreak of rabies, where even one infected dog will put a whole country-side under suspicion.

In our Union Pacific, Northern Pacific, Reading, Atchison, and Erie railways, and in our Cordage and other industrial companies of similar stamp, hundreds of millions of dollars have been lost, and at the present moment there are not less than two hundred important railways and other large corporations in the hands of receivers. The result is wide-spread distrust at home, and such utter discredit abroad that, while British consols stand at 113, and the Bank of England rate is two per cent., and while three-per-cent. municipal stocks are being applied for ten times over, and sold at a premium, the investors of Great Britain will not touch our securities at any price. Our railroad securities enjoy the proud distinction now of ranking alongside the defaulting bonds of the effete governments of Europe and of rubbing shoulders with the output of Spain, Portugal, Greece, and Turkey. But even here we wrong these poor countries by such a comparison, for they paid while they could, and they never had any intention of deceiving the investor, and were never accused of juggling with their books.

The principal source of distrust in our railways—apart from reckless competition and the physical conditions of the country—and also in our other corporations under suspicion is the manipulation of the accounts. While it is probably safe to say—and I say it on good authority—that the books of such railway companies are as well kept as they are in any other country, in so far as good book keeping is necessary for the proper working of the business and the prevention of loss from fraud by employees, the manipulation of the various accounts by the presidents or other high officials of such corporations to suit their own views or interests is so well proved and is such a monstrous offence against public morals, both in itself and in its ruinous results, that the only wonder is that it has been endured for a moment, or that Europe ever trusted us with a dollar, after it had learned our methods.

The results of the dishonest management of our corporations are both deep and widespread. They affect the engineer, the superintendent, and all officials. In fact, their malign influence overshadows all classes from the man of wealth to the man who carries a hod.

The loss or reduction of wages or emoluments is not the consequence I allude to. One of the most direct results of the dishonesty referred to, and yet one I have never seen mentioned, is the high price of real estate in our cities, and the correspondingly heavy rents. The general distrust of all forms of investment brought about by the mismanagement of our railways and other corporations, and by the continued manipulating of the market in Wall street, has caused the withdrawal of the investor from that class of security; and, with no form of stock investment in sight which he approves, he puts his money into one or more savings banks, where, though the interest is moderate, he feels the principal at least to be safe. To such an extent has this been done that the aggregate deposits in the savings banks of New York State exceed those in all the savings banks in Great Britain.*

Does this mean that the Americans are a more thrifty people? Not at all. It indicates a defect greatly to be deplored,—the absence of any other investment which the people believe in. The whole trend of the savings bank of to-day is to educate its depositors to the value of real estate. The savings banks themselves invest very largely in it, and in mortgages of realty, and, when the depositor withdraws his money, he follows the example of the bank.

Thus the reprehensible methods of our corporations, which have driven thrifty people away from other legitimate investments, have forced them to concentrate their attention, not only recently, but for decades, upon real estate, and tens of thousands of individuals, beside numerous great investment corporations, are interested in real estate to-day who, in other countries, and here under other circumstances, would have embarked their money in the stocks and bonds of corporations honestly and profitably managed, much to the advantage of these corporations and the good of the investor.

Turning to the reverse side of the shield, the fierce competition for real estate engendered in the way described has driven the price of realty in our cities, where it is better adapted for investment, to such figures that the rents are out of all proportion to what they are in more thickly populated European countries. In cities like New York

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* In 1893-4 the total deposits in the public and private Savings Banks of the United Kingdom were $595,780,052; of N. Y. State $617,089,449 and of the U. S. $1,739,006,705.

2. Every contract, document, or matter not specifically referred to in the prospectus—and calculated in any way to influence the investors' judgment—shall be void; nor can any compliance with this provision be waived.

3. Allotment cannot be made, unless the minimum subscription named in prospectus is subscribed within twenty-eight days of issue.

4. All the directors retire at the first general meeting of stockholders; after that, one-third retire annually. Only the company in general meeting can, by special resolution, remove a director before the expiration of his period of office.

5. Directors are liable for funds improperly applied, and, if they pay dividends out of capital, they may be liable for the whole amount so paid.

6. Auditors are appointed by the stockholders at general meeting. They retire annually, and are eligible for re-election. These auditors are the agents of the stockholders. They are furnished with a list of all the company's books, and to these they have access at all times. They are empowered to demand whatever information or explanation they require from the directors. Once a year at least they make a careful examination of the accounts and vouchers, and of the balance-sheet. The latter must comply, as far as possible, with the form provided by the Companies Acts.

7. On reasonable complaint, the board of trade may cause an examination of the company's books.

8. If any director, officer, or contributory of any company destroys, mutilates, alters, or falsifies any book, paper, writings, or securities, or makes or is privy to such, he is guilty of a misdemeanor, and liable to imprisonment for two years.

9. A register of members, showing the names and the number of shares held by each, must be kept at the registered office of the company, where it must be open daily to the inspection of any member *gratis*, and of any other person on payment of the nominal fee of one shilling. Copies of such register can be obtained by any one on payment of sixpence per hundred words. There is a heavy penalty for each day of refusal.

10. Every stockholder shall have one vote for every share up to ten, an additional vote for every five shares beyond the first ten up to one hundred, and an additional vote for every ten shares beyond the first hundred. Thus the holder of ten thousand shares would have only 1,018 votes.

It is especially worthy of note that the capital stock in English companies is issued only for full value in cash, except where the vendor of the property accepts stock in lieu of cash in part payment of his property. This is mentioned in contradistinction to the custom prevailing here of issuing stock against the prospective value of a road; so that in the one country the capital stock of a company always represents cash paid in and expended upon the property, and, in the other, more frequently than not, water.

Looking to the incalculable injury done to this country by corporate mismanagement in the past, and to the fact that the evil shows no signs of abatement; looking, moreover, to the continuous dislocation of our commerce, to the discouragement of foreign capital, and to the discredit into which our domestic investments are brought by it, so that our capitalists, small and large, are deprived of legitimate means of safe investment; looking to these actual results, and without considering the way in which this great country's credit and good name have been prostituted at home and abroad by railway officials who have abused their position for stock-jobbing profits,—it must seem to all right-minded men that the situation is one calling for the prompt interference of congress, either through the inter-state commerce commission or otherwise.

In the interest of corporations generally, I recommend that congress should pass a general law enacting:

1. That in future all the capital stock of a railway or other corporation over which congress has jurisdiction shall represent, not future prospects, but cash actually paid into the treasury, dollar for dollar, and expended, or to be expended, upon the property; or it shall represent property, certified by competent valuers to be worth, at the time of purchase, the full value paid for it in stock.

2. That the annual or semi-annual balance-sheets shall be in strict compliance with a form prescribed by law, such form to be prepared by skilled experts and to be very specific in its requirements. These shall vary according to the character of the corporation, whether it be a transport, manufacturing, or purely trading corporation; they shall give in every case explicit directions as to the source and proper allocation of all earnings and expenditures, and shall determine what are divisible profits and what are not. That the auditors shall be elected by the stockholders, and shall have the fullest power to examine the books at all times, and to call upon the president, directors, and officials for whatever explanation or information they may require. That said auditors, who shall be public accountants of unquestioned standing, after examination of balance-sheets, vouchers, books, etc., shall sign and present to the stockholders a statement to the effect that they have examined these carefully, and that the books are properly kept, and shall exhibit a true and correct view of the company's affairs; such statement to specify any cause of complaint which has come under their notice.

3. That the Companies Acts of Great Britain, which represent the costly experience—as well as the wisdom—of half a century in regulating corporations, be carefully examined, and such regulations as are adapted to this country be considered with a view to adoption. That for the proper carrying out of such a law congress frame certain clear directions for the treatment of railway accounts, and, with a view to preventing manipulation for stock-jobbing purposes, attach a heavy penalty to any violation of this law.

As regards the internal working of the corporations, railway and other, of course much of the value of the above recommendations must depend upon the ability and honesty of the auditors. Perhaps nothing seems so peculiar to American ideas as the influence which the reports of British accountants possess. In this country, where the word *expert* bookkeeper is too often supposed to be the full equivalent of the London public accountant or the chartered accountant of Scotland, it is unintelligible that there should exist a class of carefully-trained professional accountants, whose word is law on all questions of accounts, and who care no more for the opinions of railway presidents on such subjects than they do for that of the least important member of their office. These accountants serve fully as long an apprenticeship to accountancy as the law student does to law, and the final examination before admission is still more strict, because the accountant must be familiar with all questions of law relating to accounts, as well as with the science of accountancy. So high is the standing of the well-known accountants in London that all the great capitalizations there—frequently involving millions of pounds—are made solely on their reports, and no one ever dreams of questioning them.

In the Companies Acts perhaps no provision is more important than that which gives the stockholders access to the share registers.

Where the objective point of the directors' aims is the securing and retaining of a majority of the stock, it will readily be seen that it is a matter of prime importance with them to conceal as much as possible the names and addresses of their copartners in the company and so to avoid combinations; and thus it is that the transfer-books of a company here have a double value compared with what they have in Great Britain, and this possession means frequently the ownership of the key to the situation.

This access to names and addresses of stockholders has indirectly a very wide influence, too, in educating the public to the merits of corporation or joint-stock enterprise. Bankers, promoters, and houses of issue generally, which are engaged in the bringing-out of companies, follow up these lists very closely, and there are many firms in London to-day which have hundreds of thousands of names and addresses of investors, corrected up to date and classified. By the issue of prospectuses, which is going on all the time, excepting during periods of crises, people are gradually educated in corporation matters, so that they can form a fair idea for themselves of the merits of the scheme before them, first by the names of the directors and officials on the prospectus, and then by the character, locality, and reputation of the investment. Everything on the prospectus has a bearing on their judgment; for instance, the name of the house of issue, the names of the auditors, attorneys, valuers, and bankers,—all are closely scrutinized, for all have their special standing, which is known more or less to the intending investors. During an experience of fifty years the issued prospectuses have become a species of British literature, and, as the same names appear again and again, they come in time to have a value which is known to all with a fair degree of accuracy.

Notwithstanding the rigid requirements of the English Companies Acts, there is nothing harassing or inquisitorial in the character of the legislation in its bearing upon *bonâ fide* corporations. Within the limits of the acts named something is still possible for a dishonest promoter, but, on the other hand, the company itself is held to a strict accountability, and no majority can keep the minority from access to the books when a reasonable ground for inspection exists; nor could a majority long defy a minority which has access to the addresses of the general stockholders. But, indeed, the majority scarcely exists in Great Britain in the form that it is known here. The shares of a company offered to the public at large are widely subscribed, and in the majority of cases taken by from one to two thousand people. There are very few large stockholders, unless where the vendor of the property purchased has taken a block of stock in part payment, and, in his case, steps are taken to prevent that interest from unduly swaying the control.

The result of this wholesale education of the people is that to-day the smallest capitalist as well as the largest can find to his satisfaction just the kind of security he wants, with the further comfort of knowing that it is honestly managed. This kind of investment is less troublesome to him than the collection of house-rents or the worry and responsibility of some independent business, should he, like his American cousin, have embarked in a trade outside his own.

I think that the time will come, and possibly before long, when our people will call for such investments, and, if their cry is responded to by honest houses of issue placing sound and profitable investments before them, the gain to both will be large. Common honesty and the confidence it begets should be very profitable at the present time, and especially to those handling corporation stocks—it is so rare!

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THE ABSENCE OF FACTS ABOUT THE NICARAGUA CANAL.

By Charles B. Going.

NO recent development in national affairs is more significant than the awakened interest of our country in events and developments outside of our own geographical boundaries, and no true American but will rejoice to see his country assuming its proper influence among the great nations; but it is most unfortunate that party leaders and private promoters have been as quick as usual to seize upon a confusion between patriotism and blind expansion, and to confirm it by catchy shibboleths.

"I believe in the Nicaragua canal" is chanted vociferously by press and public, legislators and voters, leaders and led, as the first article of a new national creed, accepted in the vast majority of cases on that blind faith which the old theologians considered the proper attitude of the laity toward any formulated belief.

There is neither sound patriotism nor sane business sense in granting the national endorsement to an undertaking of this character on the basis of emotional excitement.

Before undertaking to cope with natural laws and physical facts in engineering construction, to our faith we must add knowledge. The project which we are asked to father is primarily a plain industrial enterprise based on engineering possibilities, magnificent in its proportions, it is true, but essentially similar to schemes laid before capitalists every day. It is not the province of this article to discuss the political or economic aspects of the question; the first and most important point is feasibility, which is a matter of simple evidence; until this is determined, no sound conviction with regard to the enterprise can be entertained.

The proposal which is brought before congress is that the people of the United States shall guarantee the bonds of the Nicaragua Canal Company to the extent of one hundred million dollars. We are invited to take a mortgage on a piece of property the existence of which is as yet projected only, and which will be almost wholly valueless unless successfully completed; and, while the nominal measure of our guarantee is one hundred millions, every one with ordinary experience or observation knows that, once committed to that extent, we should have to back the undertaking, without limit or reserve, to a triumphant conclusion or a miserable fiasco.

Enough is known of the topographical and climatic conditions to be encountered to suggest the magnitude of the problems involved. The work is in many respects without precedent or parallel. Surely, petitioners for such liberal support should show something more than even the most exalted faith or the most perfect intentions, and should justify their plea by the submission of so complete and accurate maps, plans, specifications, estimates, and data of geographical, topographical, and meteorological surveys that no important feature of the project could remain in obscurity, and no reasonable doubt exist as to its feasibility—from the engineer's point of view, at least.

The volume of evidence, however, without which no promoter would go before a body of capitalists and ask for one per cent. of the financial support here solicited, if existent, is absolutely unobtainable. It can not be procured from the Nicaragua Canal Company, and, when produced, may call out enthusiastic support of the canal project ; it may suggest material modification, or may demand entire condemnation of the plan ; but, until it is secured and submitted, in the name of reason let us call a halt and keep the treasury closed.

The propagandists of the canal enterprise, however, are princes in enthusiasm and paupers in facts.

The facts, indeed, are so curiously inaccessible that it is hardly possible to obtain them except in the report prepared by the board of engineers appointed, pursuant to a provision in the act of congress approved March 2, 1895, " for the purpose of ascertaining the feasibility, permanence, and cost of construction and completion of the Nicaragua canal by the route contemplated."

Of this report it would be impossible to speak too highly. Indeed, the names of Lt. Col. William Ludlow, Civil Engineer Mordecai T. Endicott, U. S. N., and Mr. Alfred Noble are of themselves sufficient guarantee of masterly work ; but even a reader wholly unfamiliar with the professional standing of the board members must be at once profoundly impressed with the thorough, able, and conscientious conduct of the examination, and the clear and systematic presentation of the results.

It is in the highest degree unfortunate that the edition of the report was so inexplicably limited that hardly a copy can by any means be procured by a private citizen. The board members were appointed as representatives of the people, to obtain all existing facts and information with regard to the property which the people are practically solicited to buy. It remains for those interested to explain why the result of the investigation is so sedulously withheld from the knowledge or inspection of those in whose very interest it was prepared.

The commissioners spent the entire time from May 7 to June 24 on the line of the proposed work, examining the ground and collecting all the data and evidence procurable from the company or from their own observations. From June 24 to July 21 they were engaged along the line of the Costa Rica Railroad and the Panama canal, examining these properties with a view of determining the effect of local and climatic conditions on constructions similar to the one proposed.

From that date until the time fixed for the submission of the report (Nov. 1), they were continuously occupied in New York in a "full and careful investigation of the company's records and data."

They express their appreciation of the fact that "the records have been placed freely and fully at the board's disposal, and every facility given for their examination." The sum of their knowledge, therefore, is the entire fund of facts compiled or observed, and of plans prepared by the company. The measure of their ignorance is coextensive with the defects and deficiencies of the company's information, except so far as the board's own observations have supplemented those of the company and reduced the great mass of existing ignorance.

This point is important; for the company, being apparently disappointed with the report, attempts to weaken it by alleging a lack of knowledge on the part of the board. In so far as such lack exists (and the board repeatedly deplores the meager information at its disposal), it merely testifies to the woeful neglect of the Nicaragua Canal Company.

The projected construction contemplates at the outset the improvement of Greytown harbor. From this point the canal is to stretch westward at sea-level to the eastern divide, the crossing of which is effected in part by three locks raising the canal level, and in part by an enormous cut 3.15 miles long and 324 feet maximum depth.

Emerging from the gigantic "east divide cut," the route traverses a series of deep basins, which are to be confined by dams and joined by short excavated canal sections through the intervening ridges. The closing of these "San Francisco basins" will require sixty-seven embankments, with a total crest length of about six miles, and heights varying from a few feet only to seventy feet and upward.

At the end of this stretch, the canal is to emerge into the San Juan river, which is at present far below the proposed summit level. The Ochoa dam, projected here, would raise the surface of the river approximately sixty feet above present low water, and, of course, flood the valley back to the lake, sixty-nine miles distant. The dam itself would have a total height of about 105 feet, abutments of 650 feet, and a 1250-foot weir on the crest to discharge surplus water. Incidental to it would be twenty-three minor embankments.

Above the Ochoa dam the canal is to follow the river, which must be deepened in the upper part, and a channel must also be dredged for fourteen miles through the soft mud of the lake.

Thence the course will be across the lake, up the valley of the Lajas to the western divide, which is crossed by a 74-foot cut, and thence down the valley of the Rio Grande to the ocean at Brito. The crossing of the torrential Tola would be avoided, in the favored plan, by the construction of the La Flor dam, with a crest length of 2,000 feet and a height of 90 feet, confining both Tola and Rio Grande in one basin level with Lake Nicaragua. From this, locks would descend to tide-level.

Even this very brief outline will make immediately apparent the magnitude of the dam and embankment work projected by the company, and the enormous extent to which it must be affected by conditions of rainfall. It is not merely a question of the preservation of dams, cuts, and embankments, however, serious though that might seem in view of the board's report that "there is a rainfall record at Greytown for the years 1890, 1891, and 1892 which shows a mean of 267 inches, a maximum of 297, and a minimum of 214," and also that "there is reliable information of precipitations of 3 inches in an hour, of 9 inches in 9 hours, and 35½ inches in 8 days."

When it is considered that the average yearly rainfall is about four times that in the rainy belt of the United States, and the nine hour precipitation equal in volume to that which caused the Johnstown flood and from two to four times as rapid, the problem of construction and maintenance under such conditions seems serious enough. But, more than that, the maintenance of the entire summit level of one hundred and fifty-three miles within the narrow limits between water too low for navigation, on the one hand, and too high for the safety of the work, on the other, must depend on an accurate knowledge of every detail of rainfall and watershed, including the accurate gaging of every stream involved.

It is, therefore, with astonishment that we read that the observations with respect to rainfall are "scattering and unsatisfactory"; that "the company has omitted attention to this matter, and made no careful gagings at any point"; that, although "the most serious problems affecting the design and construction of a canal system at the present time are those involved in the heavy rainfall and consequent discharge from the lake and streams whose variation of surface and volume must be taken into account," yet "on these points the existing data are seriously defective both in respect of number and continuity"; that, while "the height, cross-section, and volume of cuts, dams, and embankments, and the dimensions of locks, weirs, and sluices to be constructed for the maintenance and utilization of the summit level, the precautions to be taken to make these works secure, and the loss in elevation of water surface due to drought or deficiency, all these depend for their determination upon the fullest and most precise gagings of all the watercourses concerned, ... this information has not been secured.''

Truly, as the board temperately remarks, ''this omission is the more to be regretted because the company's project calls for the construction of numerous dams and embankments of magnitude, some of them without precedent in engineering practice, and all involving serious hydraulic problems.''

Following such a startling revelation of wholly inadequate knowledge, it is less of a shock to discover that, at the very first point of any difficulty west of Greytown,—that is, the crossing of the Benard Lagoon,—''the bed is *supposed* to be mud of great depth,'' in which the building of banks would be very difficult; or to learn that the plan contemplates the diversion of the Deseado river just west of Lock No. 1, although ''the flood discharge of the stream is not known''; or that an important dam has been planned near Lock No. 3, although ''no borings have been taken at this site, and it is not known whether a suitable foundation for a concrete dam can be found.''

Indeed, we are now ready to hear that ''the canal company has no detailed plans of the locks and other structures for which its estimates are made, and the board has had to prepare preliminary drawings for the lock estimates.''

But the central divide cut—the next feature of the canal, and by far the most expensive single item of the work—is an undertaking so colossal that it is inconceivable that any important plans should be based upon it, or any estimates made for it, without a thorough knowledge of the conditions to be encountered in its construction. The only investigation made by the company, however, was a pitiably scanty series of borings ''along the center line of the canal at intervals of 1,000 feet, with a diamond drill, obtaining cores of the rock passed through. ''These cores, arranged in order, would be a valuable record, but only a few samples from a small number of the borings have been preserved. These samples, with the scanty notes turned in by the chief of the boring party, and such examination of the outcrops as the board was able to make during the inspection of the route, constitute all the information now available.'' ''New borings . . . . are indispensable.''

It must be borne in mind that the company's proposed cut, at a slope of one horizontal to five vertical, would have sides so closely approaching the perpendicular that they could not be maintained, except in rock of the soundest texture. That such rock will be found throughout, the board considers extremely improbable ; indeed, it thinks the conclusion seems inevitable that "flatter slopes than those assumed by the company will be required at the outset," but it can only dismiss the subject by saying : "the board regrets exceedingly that it is compelled to present so inadequate a discussion of the east divide cut, the most costly section of the whole project ; but the data at hand are so scanty and defective that no satisfactory treatment of the subject is possible."

The next section of the canal—the San Francisco basins—is considered by the projectors* "the weakest feature in the whole route." The embankments forming these basins, as already stated, are to be sixty-seven in number. The longest will be 1.2 miles in crest length, with a maximum height of 85 feet. "At least four of these larger dams will have a height of 100 feet above their foundations" ; yet so defective are the investigations that, while "the company's borings in the beds of the Danta and Nicholson sank through thirty feet of soft mud before reaching clay," "there are two of these swamps of similar character that have not been investigated, and whose depth of mud is not known"; and, although (as first planned) "all these embankments will be, in fact, so many waste weirs for the discharge of the surplus water at several points in the basin," "it is not clear for what amount of drainage, or for what area, these weirs are intended to provide, as the streams in question have not been gaged in flood nor their watersheds measured."

By more recent modification of the plans, the dams will be relieved of the dangerous duty of acting as weirs, and provision for this purpose made by sluice openings in the adjoining hill crest ; but the criticism as to ignorance of the conditions still stands. Furthermore, while it is proposed to introduce a guard gate in this stretch of the canal, "there are no drawings nor plans for these gates."

The great Ochoa Dam, however, the "main prop of the company's project," the proposed structure which "has no precedent in engineering construction," we can hardly conceive to have been planned in ignorance of any, even the smallest, detail which could affect the erection or preservation.

"A failure here would leave navigation stranded, wreck the valley below, and wash Greytown into the sea." It must be remembered also that the dam is not only to impound the waters of the San Juan and San Carlos rivers : it is also to hold the entire lake from falling below the lowest permissible level, and to extend the summit level eastward through the basins and the divide cut to Lock No. 3.

The actual extent to which blind confidence has been allowed to usurp the place of sound and sufficient knowledge can again best be

* Mr. Menocal's paper, Chicago, 1893.

presented in the words of the board. "It is important to know: (1) what is the nature of the river-bed and banks upon and between which the dam is to be built; (2) what are the physics of the stream itself, its range between high- and low-water stages, its varying slopes, velocity, and volume, the magnitude, duration, and frequency of its floods. Unfortunately, information of this kind is seriously deficient. The company's surveys are mainly devoted to topography, and did not include the collection of hydraulic data."

"The geological investigation was both scanty and unsatisfactory."

"The (company's) party was provided merely with earth augers for boring into clay, and with pipes and sand-pumps for exploring the sandy bed, but had no drills for testing rock, if found, to ascertain its character and quantity."

"More precise data as to the extent of the floods are necessary, before the dimensions of the weirs and sluices can be fixed." "No survey was made of the river, and but one gaging, and that of no present value, as the stage of the river when it was made is not known." "The river has never been gaged at a flood stage." In other words, the company seems to have projected a dam on guess-work, and the board does not consider the guess a good one. Perhaps, therefore, it is no great matter that "the company has no detailed plans or specifications for the dam," difficult though it may be to reconcile this with the preparation by the company of total estimates for the whole canal.

But, granting, for the time being, the entire practicability of the dam, and its sufficiency to withstand the severest floods, would it retain a sufficient depth of water in the river and lake during the dry season? To quote the board again, "the regulation of the lake itself offers difficulty, and the matter is so important, and has been so completely overlooked," that "there is hardly any definite information as to the amount of water received by the lake during the dry season." "The amount of water to be dealt with, either during the year or during floods, is unknown. The annual rainfall is not known at any point between Ochoa and the west shore of the lake."

"It is to be regretted that the canal company has no recorded observations of the lake level, or other data relating to its regulation for the eight years since it began work in the country. The matter is of such vital importance that observations ought to have been made continuously during the entire period." "The whole problem of the regulation of the summit level . . . . and even the practicability of the company's project . . . . requires the collection of a large amount of information, before it can be solved."

Proceeding up the San Juan river to the point of proposed improvement, the board finds "no means of ascertaining, with any approach to accuracy, what may be the quantities and proportions of the materials to be removed, whatever may be the cross-section."

"It appears that the company has made no surveys or examinations of the sixty-nine miles of the river between Ochoa and the lake, with the exception of a partial survey by compass, which is laid aside as valueless." "The profile furnished by the company is little more than guess-work." "The omission of the company to determine these (facts) seems inexplicable." It does, indeed.

Passing rapidly over the lake without further criticism than a question as to the sufficiency of the company's dredging project, there remains only the comparatively short canal work between the lake and the Pacific: but here again, although it is proposed to dam the torrential Tola river, "unfortunately, it has not been gaged, and even its drainage area is not known."

On the site where the dam is projected, diamond-drill borings penetrated 338 feet below the surface of the ground without encountering any solid material, but, in spite of such serious discouragement, "the company is unwilling to abandon the idea of the dam."

As to the remaining part of the route it remains only to say that borings at the site of the proposed tide-lock "show a deposit of mud of unknown depth, extending at least thirty-seven feet below lock-bottom," and that, for the difficult problem of making a safe harbor of the open roadstead at Brito, "the information available is not sufficient to enable final plans and estimates to be made. The borings made under the company's direction are too few in number and of too little penetration to determine the underlying materials within the harbor limits." Such is the incredible amount of ignorance with which the company's project is invested; in spite of which, they present a grave estimate of cost, placing it at $66,466,880 by the Tola basin line, or $69,893,660 by the low-level line.

The board's idea is that the work, if practicable at all, will require an outlay of $133,472,893*; but, unlike the company, it carefully directs attention to the impossibility of making more than a vague approximation to cost. Even if the most careful determination be made of unit prices (and it does not appear that it has been) yet "it must be noted, however, that the company has made no final details or construction drawings, so far as is known, and general data are relied upon for computing cost. The only specifications drafted are those for the dredging work, and the particulars as to this are in some cases lacking in definiteness."

No space has been given in this article to the serious criticism

* It is reported that Col. Ludlow, when under examination by the house committee, expressed regret that the estimate had not been made $150,000,000.

passed by the board upon many important points of the company's project. The aim of the review is solely to make apparent the chaotic uncertainty of this imperfectly-considered and ill-assured scheme, for which the company asks the endorsement of the United States to the initial extent and nominal limit of one hundred millions of dollars, but practically to an amount which, unless the people are better advised than the company apparently wishes them to be, can only be conjectured by considering the experiences of French investors with the Panama canal. The security for this magnificent mortgage is to be, not a property, but a project; the argument for its success rests, not upon sound engineering investigation, but upon possibly brilliant, but certainly unreasoning and so far unsupported, faith; and the din of spread-eagle oratorical appeal to national self-confidence covers up the dark and mysterious silence as to physical facts.

When it is further noted that the report containing the facts is limited to so small an edition that a copy is almost unprocurable, and that, even if a copy be obtained, it will be found destitute of the twelve appendices and thirty-four maps and charts which are replete with interesting information and would make the whole clearly and immediately intelligible, it seems impossible to escape the conclusion that it is not desired that the facts should be known.

Until they are known, the attitude of every intelligent citizen should be an open mind and a close pocket,—most of all, if he be a friend of the canal. Refusal of financial backing now has no relation to ultimate conclusions regarding the enterprise. It may be not only feasible, but desirable from every point of view, but this can not possibly be determined until, as recommended by the board, at least eighteen months' time and three hundred and fifty thousand dollars have been expended in making the investigations which the company should have completed long since, but has entirely neglected.

It is understood that the rehabilitated Panama canal enterprise, profiting by bitter experience, will incur an expenditure of over one million dollars in exhaustive studies, and that it is the intention to submit all the resultant data to an international engineering board of the highest standing.

Until we follow this example, at least to the limited extent recommended by the board, an espousal of the present Nicaragua canal scheme would be more than fatuous business policy. It would be imperiling the national honor, and perhaps inviting a national shame.

RELATIONS OF ELECTRICAL AND MECHANICAL ENGINEERING.

By Elias E. Ries.

WITH the rapid march of new discoveries and inventions in science and the mechanic arts, such as has especially characterized the latter half of the present century, and the consequent increase in the application of new principles and improved methods to nearly every branch of material progress, it is not strange that, as new industries are created and the sphere of existing applications of physical and mechanical principles is widened, general engineering practice should become more and more specialized. This process of specialization has, in fact, been followed to such an extent in the science of engineering as to have gradually given rise, in many well-defined instances, to entirely new and distinct professions, having little or nothing in common with those that preceded them, except in the elementary particular of being based upon the practical utilization of certain natural principles and laws.

Engineering as a science or profession was originally applied to military operations, and was subsequently divided into two branches, designated as "civil engineering" and "military engineering." Since then the science has undergone a wonderful extension and growth, and at the present time the term is applied broadly to the planning and erection of such works and structures as involve a comprehension of mechanical and physical laws.

Nor does the modern use of the term "engineering" restrict it to the design and construction of work in which ordinary mechanical effects are the sole objects. We have to-day, for example, architectural engineering as distinguished from architecture as a fine art. So, also, the calculation and laying-out of a system or network of main and distributing conductors designed for the transmission and distribution of electrical energy, even though all the energy to be transmitted be directly converted into heat without the intervention of mechanical motion, falls entirely within the scope of engineering practice, and demands a degree of skill easily comparable to that involved in the projection of a steam railroad.

The process of specialization in the profession of engineering, due to the development in the mechanic arts, has opened many continually-widening fields for the exercise of engineering skill, each demanding more and more the exclusive time and attention of the engineer who has identified himself with and made a study of its special opportunities and requirements. The most recent of the important special additions to this constructive science is electrical engineering, and it is to the evolution and development of this science, and its relation to mechanical engineering, to which, owing to its general character and scope, it is most closely allied, that we now propose to give attention.

The relations that exist between mechanical and electrical engineering are, in more than one respect, exceedingly close, and the question of their mutual dependence has formed the subject of much discussion. Some have gone so far as to assert even that the profession of electrical engineering must eventually be absorbed by mechanical engineering, although it is scarcely necessary to say that this extreme view cannot for a moment be entertained, and that those who hold it have taken an exceedingly narrow view of the field which electrical engineering claims exclusively. Neither can it be said that electrical engineering, in its most comprehensive sense, will ever absorb the profession of mechanical engineering,—an opinion that is likewise held by probably a much larger number of those engaged in mechanical pursuits, who look with amazement upon the rapid inroads that this younger and more vigorous branch of applied science is making in many directions heretofore regarded as within the exclusive province of the mechanical designer and constructor.

It is only within the past few years that the profession of electrical engineering, as such, has had any existence. Prior to the invention and commercial introduction of the incandescent electric light, and more recently of the electric motor, there was practically no work calling for the exercise of what is now understood as electrical engineering, if we except the somewhat restricted profession of the telegraph engineer. The proper design and construction of dynamos; the planning and erection of central stations; the projection and laying-out of systems of electrical distribution; the building and equipment of electric railways; the intricate problems involved in the installation and economical operation of large electric power generation and transmission plants,—all of which to-day call for mathematical, constructive, and engineering talent of a high order,—were then unknown.

Previous to this later activity in the electrical field, in the days when the electric telegraph was almost its sole occupant, the title of "electrician" was recognized as representing a distinguished profession which embraced the highest attainments in the line of electrical practice and theory. An electrician in those days was looked up to with a feeling akin to awe and superstition by his contemporaries in other branches of mechanical work and by the general public. The marvels of the quadruplex and the ability to locate, by means of the

Wheatstone bridge and the galvanometer, the exact position of a break or "leak" in a cable buried in mid-ocean seemed not the least of the astonishing features of the electrician's art, and very justly so.

Less than twenty years ago the practical applications of electrical science were limited chiefly to the telegraph and the district-messenger service, to electrolytic processes, and to minor industrial and domestic purposes, to which the comparatively weak battery and magneto currents which then formed the only readily-available source of electrical energy easily lent themselves. Most of these earlier applications of the electric current, while coming within the sphere of the electrician's work, required less of mechanical skill than of inventive ingenuity in adapting them to the various purposes which they served, and, in the case of the more complicated apparatus, the presence of a convenient instrument-maker supplied any deficiency in mechanical knowledge on the part of the electrical experimenter.

From this time on, however, the duties of the electrician gradually embraced a wider and more responsible field of work, which called for the creation and exercise of additional knowledge and skill as the later branches of dynamic electricity presented more novel and important problems for his solution. These newer and more exacting duties of the electrician, and the remarkable results that bore testimony to his mastery of hitherto unknown electrical and electro-magnetic laws, materially aided his advancement, and caused him to assume an even higher place in the eyes of his contemporaries than he occupied in the earlier days of the telegraph.

Since the commercial advent of the dynamo-electric machine and the consequent cheaper production of electrical energy in large units, followed by its speedy utilization in the form of light and power, the profession of the electrician has by degrees expanded so as to include that of the mechanic and engineer. The practical electrician of former times, who was fully qualified in the application of Ohm's law to the measurement of resistances and to the electrical testing of batteries and circuits, seemed to be, in the majority of cases, quite incapable of developing the mechanical constructive ability needed in the newer and heavier work which the generation and commercial application of these more powerful electric currents have called into existence.

It was during the early days of this period of activity, and in the practical but expensive school of experience, that the evolution of the electrical engineer commenced. Although his path was beset with difficulties, he eventually proved himself equal to the emergency, and in due time became thoroughly acclimated to his new environments. Not until 1884, however, did the new profession of electrical engineering receive substantial recognition as such, by the organization, on May 13 of that year, in New York city, of the American Institute of Electrical Engineers, to which institution and the valuable papers brought before it by its members, who now number something over one thousand, is due not a small share of credit for the gigantic strides that have been made in electrical engineering, as well as in general electrical science, during the past decade. Nor was it until some years later, when the installation of electric lighting and power stations throughout the country, followed by the experimental operation of a number of lines of electric railway, had demonstrated the pressing need for educated electricians possessing a combined electrical and mechanical training, that the course of electrical engineering was placed upon the curriculum of our colleges and universities. The first educational institution to adopt this course of advanced electrical instruction leading to the degree of "Electrical Engineer" was Columbia College of New York in the year 1889, since which time special attention has been given to practical instruction in electrical engineering by most of the prominent universities and by many technical schools in this country and in Europe.

Prior to the advent of the electric motor and its applications to mechanical and manufacturing industries, mechanical engineering was supreme in its command of the entire range of mechanical design and construction as applied to technical work. The education of the mechanical engineer was considered sufficiently complete, if he possessed a thorough knowledge of the laws of motion and of the principles of mechanical and other simple physical forces. such as hydrostatics, pneumatics, and heat: if he was familiar with the theory and construction of the steam boiler and engine, and with the principles of mechanical drawing and machine design; and if he had enough mathematical training to enable him to figure out the strength and proper proportion of the materials needed in the different portions of his work. This, with a certain amount of practical experience in machine construction and a general study of applied mechanics, was ample to enable him, if he possessed a reasonable degree of originality, to cope with any problem that might confront him in his professional career.

There is still, of course, and always will be, an enormously large field for the profitable exercise of a thorough mechanical training such as this. But, in view of the growing use of the dynamo and electric motor in manufacturing establishments and in modern machine-shop practice, in which they are now either supplanting or supplementing the steam boiler and engine (to say nothing of the increasing use of electricity in other technical and industrial processes), the up-to-date mechanical engineer must familiarize himself, if not with the fundamental principles of electrical science and the elements of electrical and electro-magnetic calculations and measurements, at least with the mechanical design, construction, operation, and control of the dynamo and motor and its general applications, in so far as the same may be useful to him in determining to what extent and in what connection the employment of electrical energy as a motive or controlling force may best be used in his construction work and other problems arising in his daily practice. Electrical applications, in fact, are so rapidly assuming an important place in nearly every department of engineering that an *elementary* knowledge of the science and its various uses in connection with his special department is to-day an essential requirement of every engineer, and particularly of the mechanical engineer.

It may be said, however, that, in this inventive and constructive age, the field of purely mechanical engineering and design will always remain so large, and form so great a proportion of our material progress, that, instead of diminishing, the work of the every-day mechanical engineer will continually increase, being, in fact, enhanced by the competitive activity in the electrical field ; and that he will, therefore, find enough to do in his particular specialty without attempting to master the more difficult technicalities and daily increasing problems that confront the electrician and electrical engineer, which properly belong to an entirely different branch of physics and demand an entirely different treatment from that falling within the ordinary and most efficient training of the mechanician and mechanical engineer.

Owing to the misconception that popularly prevails regarding the distinction to be drawn between the occupation or calling of the electrician and that of the electrical engineer, the two vocations being frequently looked upon as identical, it may be well to define this difference before proceeding to investigate the duties of the electrical engineer and the relations between him and his mechanical brother.

The electrician bears very nearly the same relation to the electrical engineer that the mechanician does to the mechanical engineer. The modern electrician should possess a thorough knowledge of physical as well as electrical science. He must have made a complete study of all electro-static, electro-magnetic, and electro-dynamic phenomena known to the science, especially those that have a bearing upon his special work, and must be familiar with the laws governing the same and with their practical application. He must understand electrical testing and measurements, and be familiar with the use of instruments employed in connection therewith, and with the use of algebraic formulæ. His theoretical and practical training may be, and frequently is, of an exceedingly broad character, depending upon the range of experimental and practical work to which he applies himself. It sometimes covers the entire range of electrical invention and experimentation, but more often is confined to some particular line or lines to which he devotes special attention.

Although the vocation of the electrician does not in itself demand a comprehension of mechanics in its practical sense, yet a theoretical understanding of mechanical principles is more or less essential to, and is usually possessed by, him, especially if he is of an original or inventive turn of mind. As a rule, however, the function of the electrician does not extend into the domain of mechanical, or of engineering, practice, as does that of the electrical engineer. In the exercise of his duties he may be said to occupy an intermediate place between pure theory and advanced practice, in the application of electrical principles to various scientific and technical uses as well as to the minor commercial and industrial purposes that do not call for the exercise of engineering skill.

In order that the status of the electrician may not be misunderstood, it may be remarked that the advanced electrician who keeps himself in close touch with modern developments in his science very often has a more comprehensive and exact knowledge of the latest and most desirable practice in any particular branch of the art than the electrical engineer who limits himself to a single branch of electrical engineering, or to a certain type of installation, to such an extent as to be unable to grasp or utilize the advances made in some analogous line of work.

Coming now to the consideration of electrical engineering, we may at the outset divide this profession into two distinct classes, the one analogous to civil engineering and the other to mechanical.

The first class of electrical engineering, which includes also the profession of the "consulting" electrical engineer, embraces the application of electrical laws and principles to the projection, construction, and installation of more or less extensive works, in which electrical energy in one or more of its various forms is to be utilized. Examples of this class of electrical engineering are to be found in the work of devising, calculating, and mapping out systems for the generation, transmission, and distribution of current for electric lighting, heating, and power purposes and in adapting the same to the continually-varying conditions and requirements met in practice.

This class of electrical engineering is, for the most part, selective rather than constructive, but, nevertheless, requires a complete knowledge of the principles of both electrical and mechanical science, and a practical training in the application of these principles to the special class of work in hand. The perception and proper economic application of the laws governing the generation, distribution, and utilization of electrical energy, particularly in the form of alternating currents of various phases and frequencies, demands a high degree of scientific, mathematical, and engineering proficiency, as any attempt at solution of some of these problems on the part of the novice will demonstrate. As a rule, however, the practical electrical engineer usually works with standard or well-tried formulæ, and is, therefore, not so much concerned with original experimental investigations.

The second class of electrical engineering alluded to, which is the one most closely allied to mechanical engineering, is that which has to do with the practical design and construction of electric generators, motors, transformers, and other electro-mechanical apparatus.

The intelligent and successful practice of this division of electrical engineering, which may be termed the constructive branch, requires by all odds the application of the highest degree of electrical, mathematical, and mechanical skill. Not only is a complete knowledge of mechanics and the principles of machine design requisite, but also a most thorough comprehension of the laws of electro-dynamics, and the ability to apply them successfully to the calculation, design, and construction of the various types of apparatus under consideration, and the proper mechanical adaptation of the same to the special duties required of them. The formulæ for the calculation of current and electro-magnetic induction, particularly in connection with the design and construction of alternating current apparatus, are exceedingly complicated and difficult of application, while the correct proportioning of armature and field coils and the proper subdivision and winding of armatures of certain types of dynamos and motors, however simple the same may finally appear in regular manufacture, is scarcely less difficult when it comes to the precalculation of these various features for a new or special class or size of apparatus.

Among the many kinds of apparatus whose design and construction properly fall within the province of the "electro-mechanical engineer" may be mentioned:

First, electric generators, or machines for the conversion of mechanical into electrical power. These, commonly known as dynamo-electric machines, or simply as dynamos, are of a wide variety in design, appearance, principle of construction, methods of operation and regulation, character of output, and range of work,—so wide, indeed, that it is doubtful whether any other single class of mechanical apparatus presents, in its different applications, such diversification.

Second, electric motors, or machines for the conversion of electrical into mechanical power. This includes not only the design and construction of ordinary electric motors, but their design and adaptation to special classes of direct-connected work, including the design and construction of the necessary gearing and controlling devices in connection with such work, and the proper installation of the same.

Third, transformers, or machines for converting a current of a given pressure or voltage into one of a lower or higher pressure, or for converting an alternating into a continuous current, or *vice versa*.

In addition to these, there are many other forms of electro-mechanical apparatus that are now coming more and more into use, all of which demand, not only a thorough proficiency in mechanical as well as electrical science, but full conversance with laboratory and machine-shop practice. In short, to be efficient, he must combine the profession of the electrician with that of the mechanical engineer.

The importance of correct mechanical design and construction in electrical-engineering practice cannot be too strongly dwelt upon. In the early stages of this art, examples were not wanting to show how inadequately the need of proper mechanical construction was appreciated, due in a measure, no doubt, to the more pressing electrical problems with which the pioneers in this field had to contend. The history of the electric-railway industry forms a conspicuous illustration, and one that is doubtless still fresh in the memory of many of the readers of the ENGINEERING MAGAZINE.

It is probably safe to say that the early practical difficulties encountered by many of the electrical pioneers in the magnificent development we now see about us were chiefly due to a failure to adequately appreciate the close relations that exist between electrical and mechanical engineering, and to the necessity they were usually under of entrusting the mechanical execution of their plans to mechanical or engineering experts, who had little or no previous experience with electrical work, were not acquainted with the character of the electrical laws in accordance with which they were expected to build, and were consequently unfamiliar with the intimate relations between the motor and its work, and the important reactions that quickly manifest themselves in the motor, for better or for worse,—usually for worse,—in accordance with the design and operation of its own and its connected mechanism.

Not alone the mechanical, but also the electrical, requirements of dynamos, as well as motors, were at this period but imperfectly understood. To the excellent educational facilities now afforded the young aspirant for electrical-engineering honors, which have lately enabled him to combine with the scientific and technical training of the electrician a more or less thorough practical knowledge of applied mechanics and of machine design, the modern perfection in electrical construction is largely due; and it is a high tribute to the progress in electrical science in recent years, as well as to the intelligence of the electrical engineer, that at the present time the predetermination of the characteristics of dynamos, motors, and other electro-mechanical apparatus has been reduced to an exact science.

Having now reviewed the manner in which the profession of electrical engineering was developed, and having seen that its present perfection is largely due to mechanical engineering, which is essential to, and in some respects identical with, it, the question may possibly be asked : "Why not remove the dividing line entirely, and combine the two professions as one? Is not the science of electrics, as related to the profession of mechanical engineering, a purely mechanical agency or power in the same sense as pneumatics, hydraulics, heat, steam, and other dynamical forces, and, as such, should it not be studied and utilized by the future mechanical engineer as he would study, select, and utilize any one or more of these other forms of energy in his daily practice, as occasion demanded? And, if so, since engineering is primarily a mechanical profession, why should there be any occasion for the separate existence of the electrical engineer?"

If what has already been said is not sufficient to indicate the only correct answer to these questions, they may be finally disposed of by stating that, like the science and practice of mechanics, the science of electro-dynamics is in itself a distinct and intricate art, and that, while the advanced practitioner in each profession should possess a good theoretical and general knowledge of the other, it is essential that he devote himself to, and make a special study of, the practical details pertaining to his particular sphere of labor, that he may achieve the highest success in his own profession.

The activity in the engineering field is so constantly increasing, owing to new developments, that there is a continual tendency toward further and further specialization and segregation in its several departments, as in other branches of human endeavor.

Electrical engineering, in its broad sense, is as yet a comparatively new art, but, as a profession, it has already grown to occupy so wide a field that it is becoming necessary to subdivide it into special branches, just as to-day the profession of mechanical engineering is also subdivided into steam, hydraulic, pneumatic, sanitary, and other special branches, each practised by mechanical engineers who are proficient in these particular lines and are, therefore, better qualified to keep in touch with, develop, and apply the latest scientific discoveries and the most approved methods and appliances in their particular line of practical work. The profession of electrical engineering has come to stay, and, to judge from the facility with which the new power represented by it is applicable to other arts, it bids fair to eventually take precedence of all other departments of engineering science.

DOMESTIC ARCHITECTURE IN WASHINGTON CITY.

By Glenn Brown.

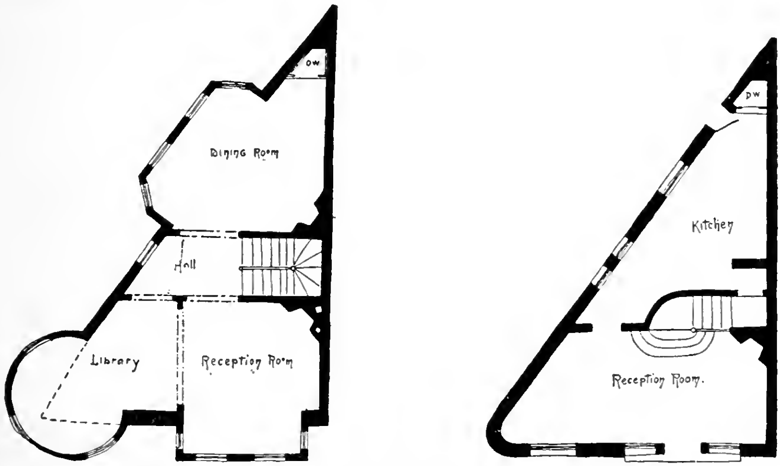
PETER CHARLES L'ENFANT, who drew the plan of Washington city, and Gen. Washington, who modified and finally adopted it, showed themselves to be men of forethought and breadth, with a true conception of how the capital city of a great republic should be laid out. Washington has the exceptional advantage of having been planned as a large city, in the map authorized by congress in July, 1790, and made in 1791. The first president, who understood the situation clearly, gave close and painstaking personal attention to even the minutest details in reference to the new federal city.

President Washington, L'Enfant, and Ellicott (who was doing the field work) made a thorough investigation of the ground, and, as a note on the map says, "carefully selected the sites of the great edifices where they would command the greatest prospect and be susceptible of the greatest improvement." After these sites were selected, avenues were laid out, radiating from the capitol and president's house, and one or two other important points. This method was adopted, as L'Enfant says, "to preserve through the whole a reciprocity of sight" between the points of interest and beauty in the city. This arrangement, while affording an opportunity for satisfactory views of the government buildings, at the same time furnishes direct access to all parts of the city, and makes the avenues the natural arteries along which traffic and travel find their way.

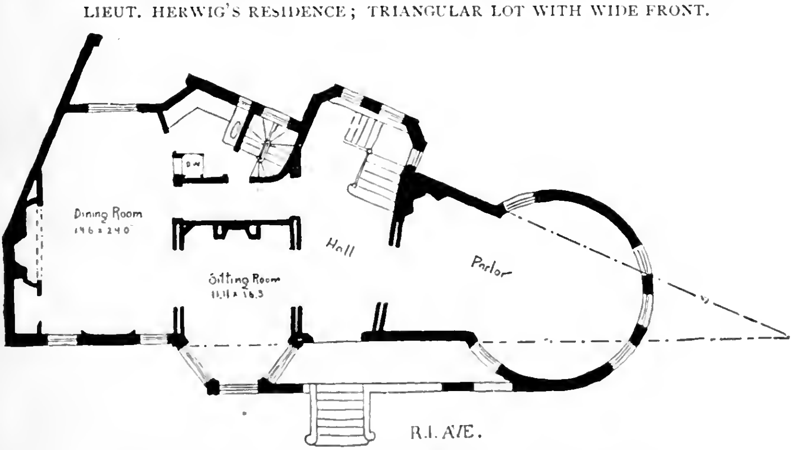
Commercial and domestic architecture is also necessarily modified by the unusual plan of the city. The wide streets and small triangular, circular, and square parks at intersections of avenues and streets give one a sense of breathing space and at the same time an actual opportunity to see the structures erected on the building line.

Buildings should be designed here with greater care than is necessary in many cities, as there are always points of sight from which they can be examined and studied, and the good or bad which is in them is especially liable to produce elevating or debasing effects on the taste of the community.

The avenues, cutting across the streets at varying obtuse and acute angles, give great variety to the form of lots, and at the same time give opportunities for picturesque and varied effects in building, and require ingenuity in the arrangement of interiors. This variety in the form of lots and the right granted by congress to project certain portions of the fronts of structures over the building line on government ground in the form of bay and oriel windows, towers, and porches gives the domestic architecture of Washington a variety, and often a picturesqueness, which are pleasing. The plans accompanying



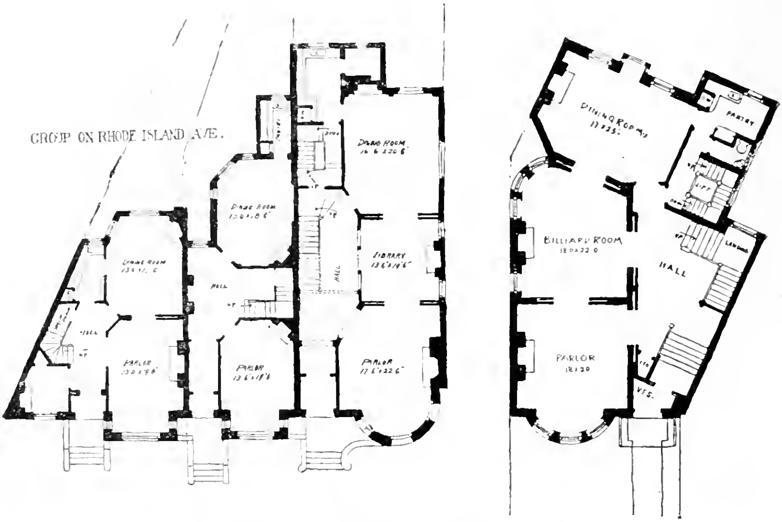
LIEUT. HERWIG'S RESIDENCE; TRIANGULAR LOT WITH WIDE FRONT.



THE SIMPSON HOUSE; ANOTHER TREATMENT OF THE TRIANGULAR LOT.

the text illustrate several varieties of arrangement, and indicate the advantage taken of government ground by the projections on the fronts. It must be remembered that the government owns streets, parks, and parking.

In many parts of the city lots have acute angles formed by the in-



A GROUP OF HOUSES ON IRREGULAR LOTS.

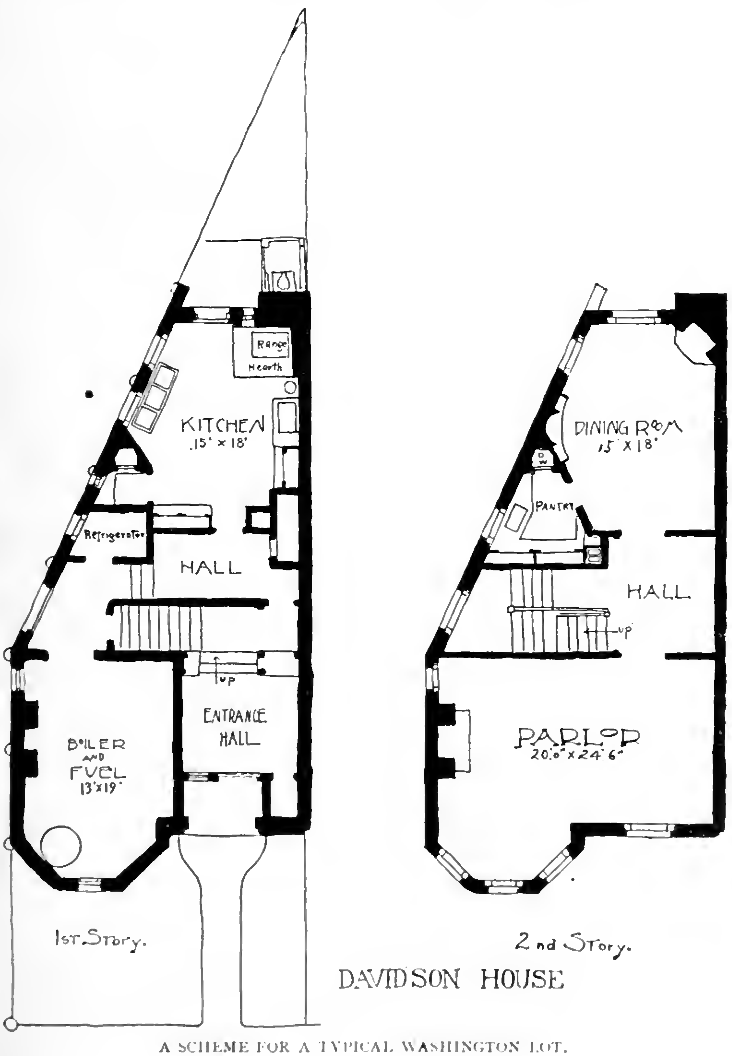
tersection of a street and avenue. Lots of this character allow ample opportunity for light and air on all sides, but usually give very little room for a dwelling. The Simpson house, located on Rhode Island avenue and P street, gives a solution of the problem in which all legal rights to projections have been utilized.

It is a frequent occurrence to find triangular lots with only one side facing the street, and the rear running to a point. The plan of Lieut. Herwig's residence shows how a house has been built on a triangular lot, 26 feet front and 36 feet deep, or on 468 square feet of ground, by taking advantage of the street privileges. The corner one of a group of houses on Rhode Island avenue near Seventeenth street illustrates how this question has been solved where the area of the lot gave greater latitude.

It has been a custom in laying out lots to run the lines, where possible, at right angles to the street fronts; near the intersection of streets and avenues this makes sites of innumerable forms. One with a narrow front and a wide rear is shown in the Rhode Island avenue group, while the Cameron house is located on a lot with lines running in five different directions. The Davidson house gives another scheme for a typical Washington lot.

There are no private residences in Washington equaling the palatial structures so common in many of our large cities. However, the city has homes of dignity and refinement, which have been erected at different periods in its history, from 1800 to the present time. Within the last ten or fifteen years it has become more and more the custom for people of culture and wealth to have at least a winter residence in the city, and in these residences their ideas as to a home have been interpreted by different architects with more or less skill. Many of these, I think, rank with the best work in the country, when the amount expended in their erection is taken into consideration.

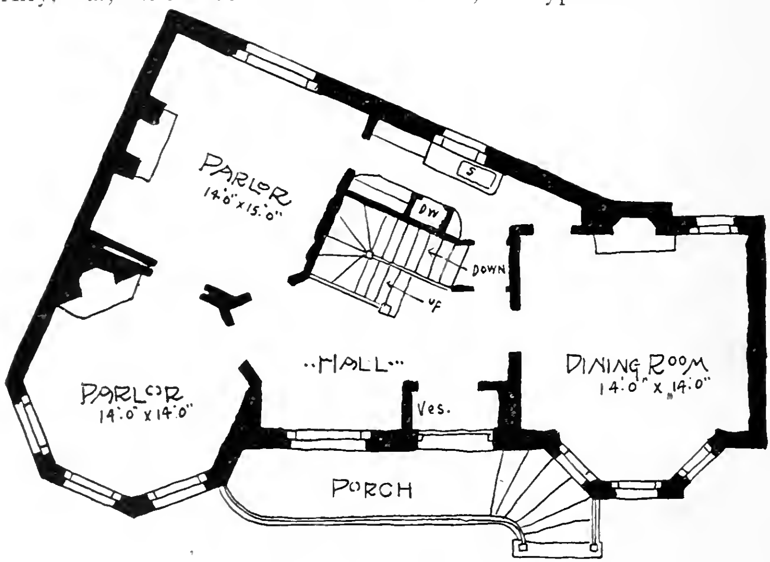
The history of Washington commenced with the establishment of the federal city; by the same act of congress buildings were directed



A SCHEME FOR A TYPICAL WASHINGTON LOT.

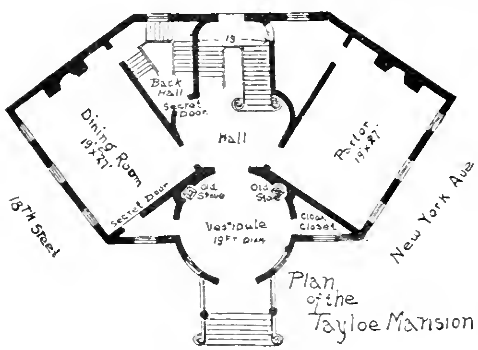
to be ready to accommodate the executive and legislative branches of the government in 1800. The dwellings in Washington at that time were few, and consisted of a small number of houses on Pennsylvania avenue, houses erected on East Capitol street, near the capitol, by the architect, William Thornton, for Gen. Washington, and some detached houses, like Duddington, the residence of Daniel Carroll.

The Octagon house,* the city residence of John Tayloe of Mount Airy, Va., which was finished about 1800, is a typical house of the



PLAN OF FIRST STORY

A RESIDENCE ON 18TH STREET.



THE OCTAGON HOUSE.

best class belonging to that period. It was designed by William Thornton. The plan shows how one of the first Washington architects solved the problem of irregular sites. The exterior is as dignified, simple, and pleasing to-day as it was nearly a hundred years ago, when

* Measured drawings, with detailed description, of this house were published in the *American Architect*, January 7, 1888, by the author.

it was the scene of entertainment and fashion. In its rooms all the prominent Americans and foreigners met and were *fêted*, and Madison occupied the building after the destruction of the interior of the White House by the British in 1814. The interior is interesting in plan and in the detail of doors which are of mahogany ; also in the mantels, some of which are of cement and others of wood with putty ornament. It is one of the few well-constructed houses of that period, and, although neglected for many years, it is still in an excellent state of preservation.

During the period between 1800 and 1820 Benjamin Latrobe designed several residences,—among them the Van Ness house, built about 1812. Although noted for its situation, surroundings, and entertainments, it does not look as if it could ever have been satisfactory from an architectural standpoint, as the proportions are not good, and the detail is lacking in refinement and the workmanship indifferent. It is probable that the interior, through its furnishing and fixtures, was at one time striking and interesting, but all of this work has been taken away. One of the old marble mantels now in Chamberlain's Hotel, by Thorwaldson, is an excellent example of his work, two figures well-modeled, in repose, making a mantel rarely equaled at the present day. The Tudor house in Georgetown, built about 1818 from the design of William Thornton, has a dignified exterior, but is not equal in refinement to Thornton's earlier work.

The buildings erected between 1825 and 1850 were influenced by the revival of Greek forms in details and porticoes, due probably to the many books on Greek architecture published just prior to and during that period. The details in brick and wood are often very interesting.

About 1850 A. J. Downing, an architect, erected several buildings,—among them the Cook and Dodge residences. These are in what Downing called the Italian Villa style, having large porches, ample projecting cornices, and simple and dignified outlines. These residences have an individuality, a harmony with their surroundings, and a suggestion of hospitality and comfort that are very pleasing.

After 1860 came the mansard roof with monstrous dormers and cornices and every variety of form and grotesqueness that one can imagine : this continued, with many undesirable productions, until what was called the Queen Anne revival about 1878 or 1879, when gables and towers, hips and valleys, bays and oriels, frequently oddities piled upon oddities, proved refreshing after the monstrosities perpetrated in the name of Mansard. Gray and Page were the most successful architects in the domestic work of that period, erecting many buildings which at the time were thought very attractive : but these houses did

THE OCTAGON HOUSE, COMPLETED IN 1800.

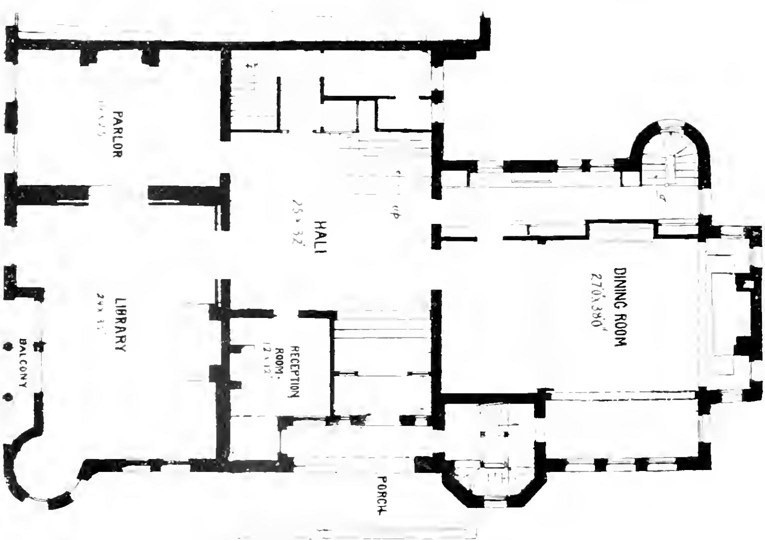
not have what may be called "staying" qualities. All residences of that period were deficient in repose, refinement of detail, and dignity of *ensemble*, their interest centering in their many oddities. I do not think there is a single example of the Queen Anne period of which one would wish to preserve a record except as a matter of history.

It was while the Queen Anne was at its height that H. H. Richardson's first house, the residence of Gen. Anderson, Sixteenth and K streets, was erected in Washington. It was the first example of what was called Romanesque work in the city. It was so striking in its difference from the prevailing work, with its large, unbroken wall surfaces, small openings, and high, simple, and expansive roof, that it attracted attention and caused comment favorable and adverse. The general verdict—and it is probably correct—has been that the building is too heavy and massive for a private dwelling. Yet it improves upon more intimate acquaintance. The proportions are so good, the massed detail is so effective and refined, the lack of pretension and show is so evident, that we must look upon this as one of the houses that will be pleasing to future generations.

Richardson, in the few years intervening between the erection of this house and his death in 1886. designed in the same style the Adams and Hay residences, in one group, and the Warder residence on K street. The former houses are not as simple or massive as his first, and are more in harmony with the prevailing idea of private residences. The general outline is not as pleasing as in the Anderson house; neither is the combination in color produced by the red brick and light stone so effective as the simple brick work of the first-mentioned residence. The low basement story of the Adams house is quaint in effect and charming in detail. The large entrance archway lead-

THE ADAMS RESIDENCE; PART OF A GROUP.

THE ADAMS AND HAY RESIDENCES.



PLAN OF THE HAY RESIDENCE.

ing to the front entrance of the Hay house is very striking and massive,—too massive for the entrance to a private house.

But it is in the interior of these houses that some of their most interesting features are to be found. The halls are very striking in their generous size and quiet, but effective, detail.

The Warder house is in every way the most satisfactory residence, as well as the most satisfactory work by Richardson, in Washington. It is built of light stone with a red-tile roof. The house is L-shaped, giving a garden enclosed by a stone wall. This

DOORWAY OF THE WARDER RESIDENCE.

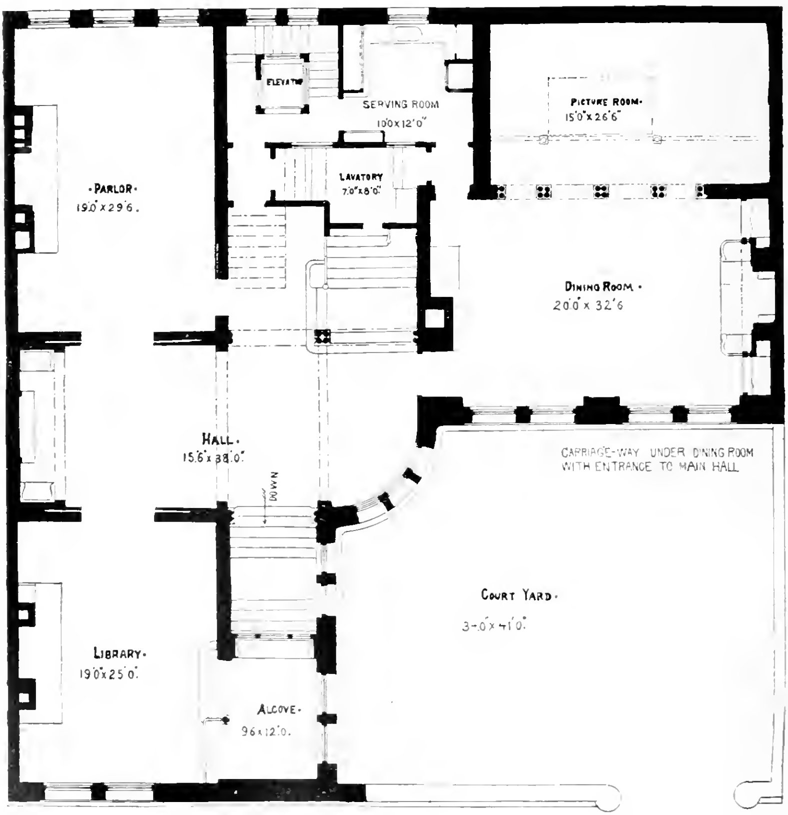
HALL AND STAIRWAY; RESIDENCE OF JOHN HAY.

PARLOR IN THE WARDER HOUSE.

HALL OF THE WARDER RESIDENCE, SHOWING STAIRWAY

DINING ROOM, WARDER RESIDENCE.

form, while giving an appearance of privacy, at the same time affords the occupants an outlook over the garden to the street beyond. The proportions, details, and color are all in harmony, and it is a pleasure to view it as a whole or examine it in detail. The main wall, slightly battered, gives a remarkable appearance of stability, while a slight curve (entasis possibly it might be called) in the quarter tower at the angle, though not noticeable, gives a refinement of outline that is felt. While none of the rooms are large, the hall, dining-room, and parlor are generous in their appearance, and the combination of natural stone, wood, and hangings are all in keeping with each other and most effective. The hall is in dark red oak, with chimney-piece and columns in red stone. The dining-room is in black oak, with Sienna marble fire-place and a



PLAN OF THE WARDER RESIDENCE.

HALL CHIMNEY PIECE, WARDER HOUSE.

Sienna marble screen between it and the art gallery. The parlor is finished in white holly, with blue satin hangings.

The architectural profession was influenced in Washington, as it was in all parts of the country, by Richardson's work, and for eight or ten years we have had what are called Romanesque buildings, a few good, a large number mediocre, and the majority very bad.

Among the most interesting exteriors in this style is that of the Whittemore house (H. L. Page, architect) on New Hampshire avenue, which is very satisfactory in outline with its high sweeping roof over a simple, low, well-proportioned, and harmoniously-colored building. An old building which the same architect remodelled in the same style for Senator Hearst has some of the most effective detail, both in interior and exterior, to be seen in the city.

THE WARDER RESIDENCE, ON K STREET.

The exterior, as a whole, is lacking in dignity and repose, and the interior is not well adapted for the movement of crowds, although the rooms in themselves, from their size, decoration, and detail, produce the impression of finished productions.

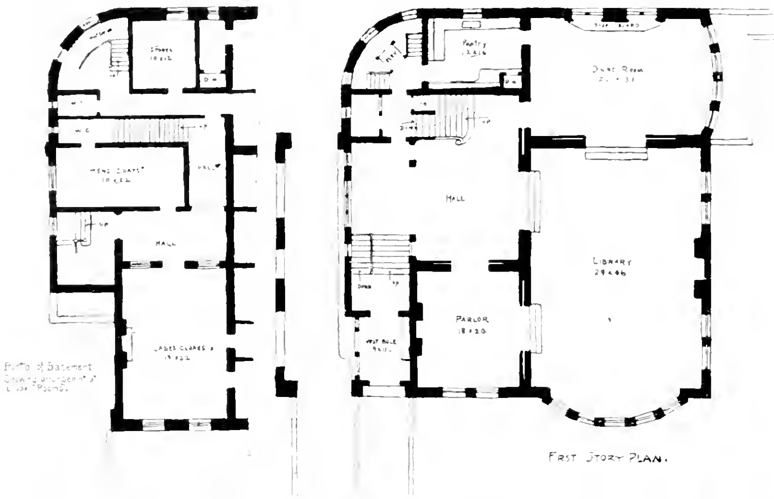
I consider next in importance to the Warder house two residences designed by Hornblower and Marshall,—the Tuckerman and Boardman houses. The first is located directly on the building line, but all the principal rooms are in what would ordinarily be called the rear. In this case it is the garden front, and there is ground sufficient for the effective garden arranged in the rear. The garden front is the most attractive, as it should be. The best should be reserved for intimates. The exterior is simple and dignified, conveying the impression of a comfortable home. The interior is well arranged for entertaining, and for effective vistas through the suites of rooms to the garden beyond them.

The Boardman house is a very massive structure, the exterior of which is built of mottled brick and terra cotta,—solid, substantial, well-proportioned, and destined to stand for years as one of the prominent residences of the city. The details, which show decided classical tendencies, are refined, and in strict subordination to the mass of the structure. The plan shows some novel features.

THE WHITTEMORE RESIDENCE.

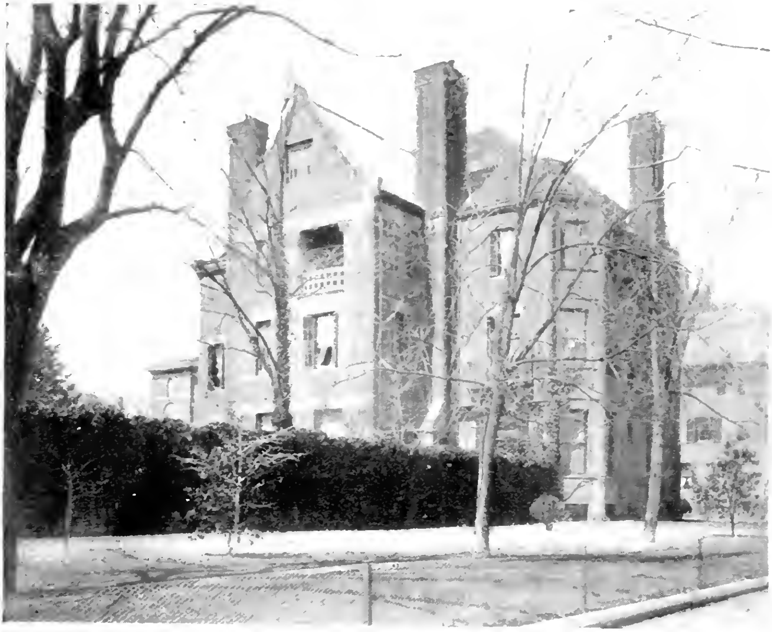
DINING ROOM IN SENATOR HEARST'S HOUSE.

The dressing-rooms are in the basement, with separate flights of stairs for the guest passing from the carriage to the dressing-rooms and from the dressing-rooms to the entertaining-rooms. The rooms and hall are very spacious, and the decorations simple, but effective.



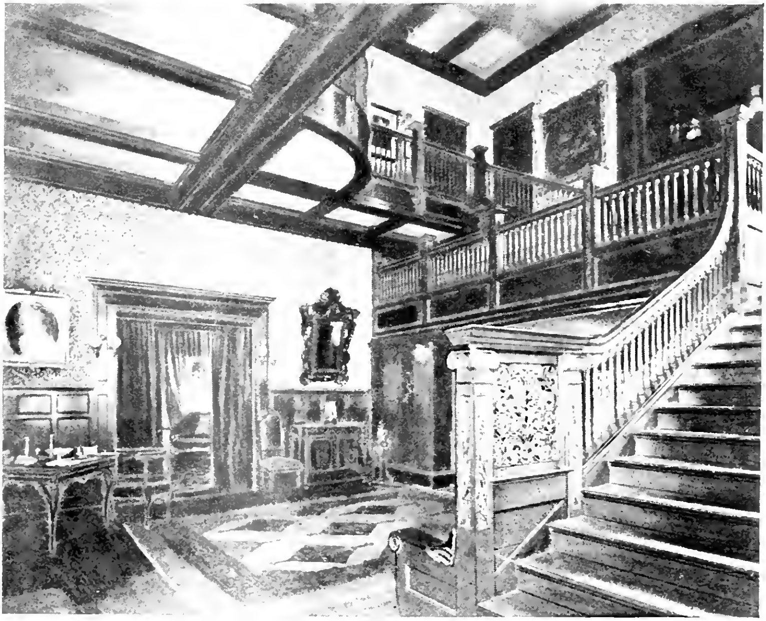
PLAN OF THE BOARDMAN RESIDENCE.

THE LIBRARY, BOARDMAN HOUSE.



THE TUCKERMAN RESIDENCE.

THE BOARDMAN RESIDENCE.



DINING ROOM AND HALL, BOARDMAN HOUSE.

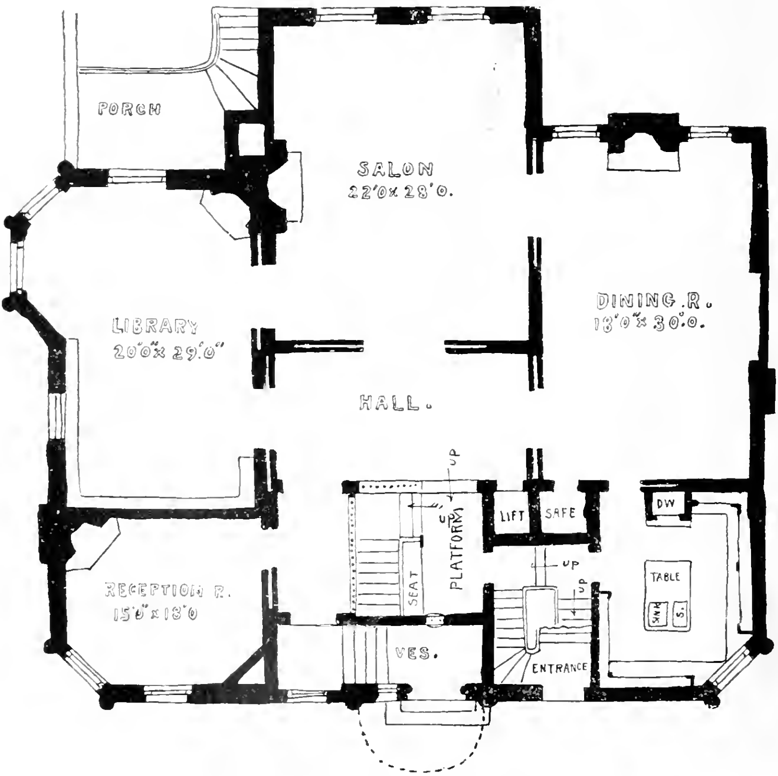
LIBRARY MANTEL, BOARDMAN HOUSE.

Houses called Romanesque have been scattered from one end of the city to the other, just as similar houses have been built from one end of the country to the other. Several houses designed by Mr. Wendell in this style, built of white stone, notably the residence of Mr. Carpenter, on Sixteenth street, show both skill and good taste. There are many of this style that fail of being good by the straining after variety and the overloading of detail, with no attention to the mass, among which may be classed the numerous houses designed by Mr. T. F. Schneider.

The abominations in the way of ill-proportioned structures with crude and meaningless details are legion, the designer usually contenting himself with several semi-circular arches, and grotesque carvings, as sufficient warrant for the title Romanesque.

About four years ago the old Colonial renaissance made its influence felt in this city, the designers dividing themselves sharply into two classes. One makes an effort to reproduce the Colonial house with archæological accuracy; the other strives to imbibe the spirit of the old work without literally copying any portion of it. The houses belonging to the first class have not reached the point where they merit description, while two of the latter are among the most interesting residences,—Senator Eugene Hale's residence, Sixteenth and K streets, designed by Rotch & Tilden, and the Frazier residence, corner of Twenty-first and R streets, designed by Hornblower & Marshall.

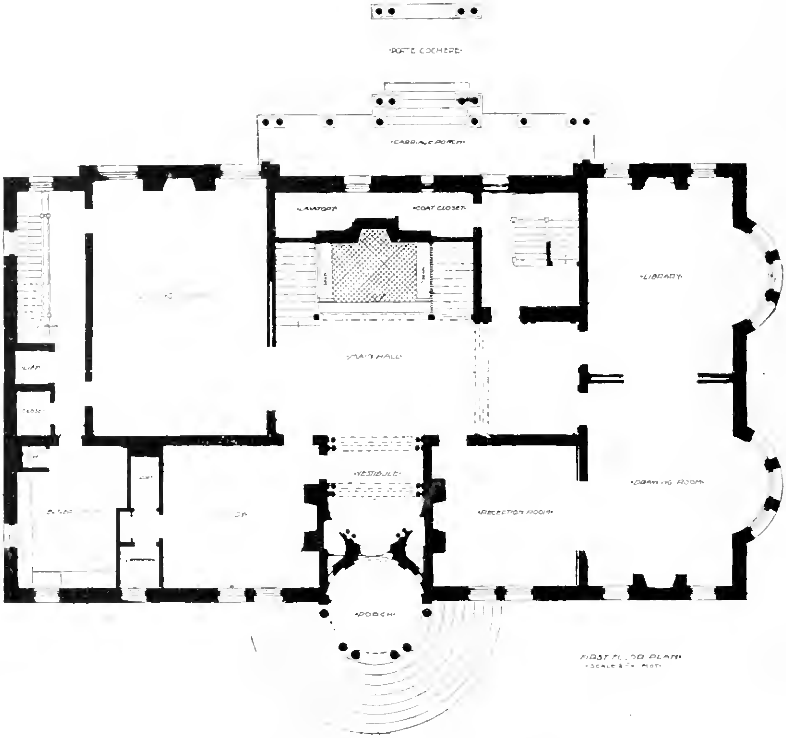
Rotch & Tilden (since Arthur Rotch's death Geo. T. Tilden), in designing the Hale house, gave a broad front on Sixteenth street, the



PLAN OF THE TUCKERMAN HOUSE.

RESIDENCE OF SENATOR HALE.

PARLOR IN SENATOR HALE'S HOUSE.



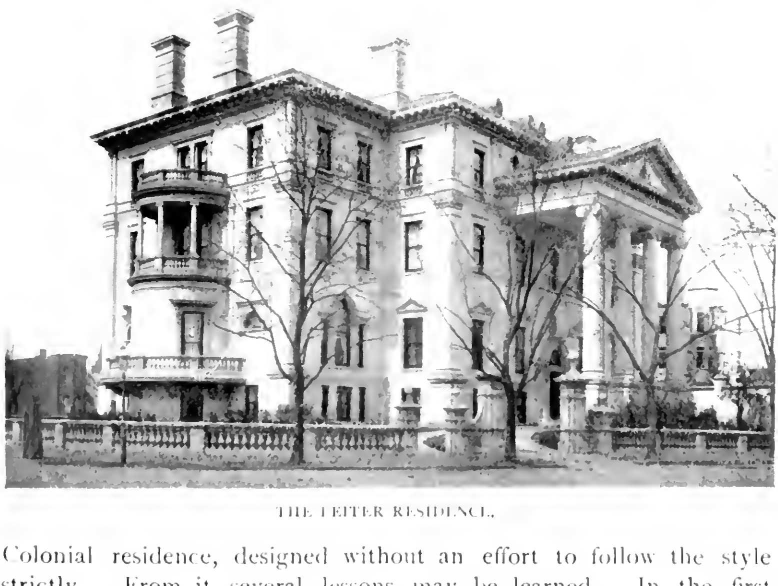
PLAN OF SENATOR HALE'S RESIDENCE.

only projection being the portico and window balconies. The exterior is of buff brick, with Ohio stone trimmings. The roof is a greenish yellow tile. Although some of the details, which are of course classical, may be criticised, as a whole the exterior ranks as one of the most effective in the city, being dignified, simple, and harmonious in outline and in color. The parking gives the house, although on the building line, the effect of being surrounded by grounds of its own. The arrangement of the interior will be best understood by a study of the plan and interior views.

The Frazier house is a square red-brick structure, the cornice and other ornamental features being in red portage stone and the whole covered by a red-tile roof. The exterior is effective as a whole, and shows refinement when examined in part. The illustration gives an excellent idea of the distance that is obtained by the broad avenues of Washington.

The Leiter house, designed by T. P. Chandler, is another old

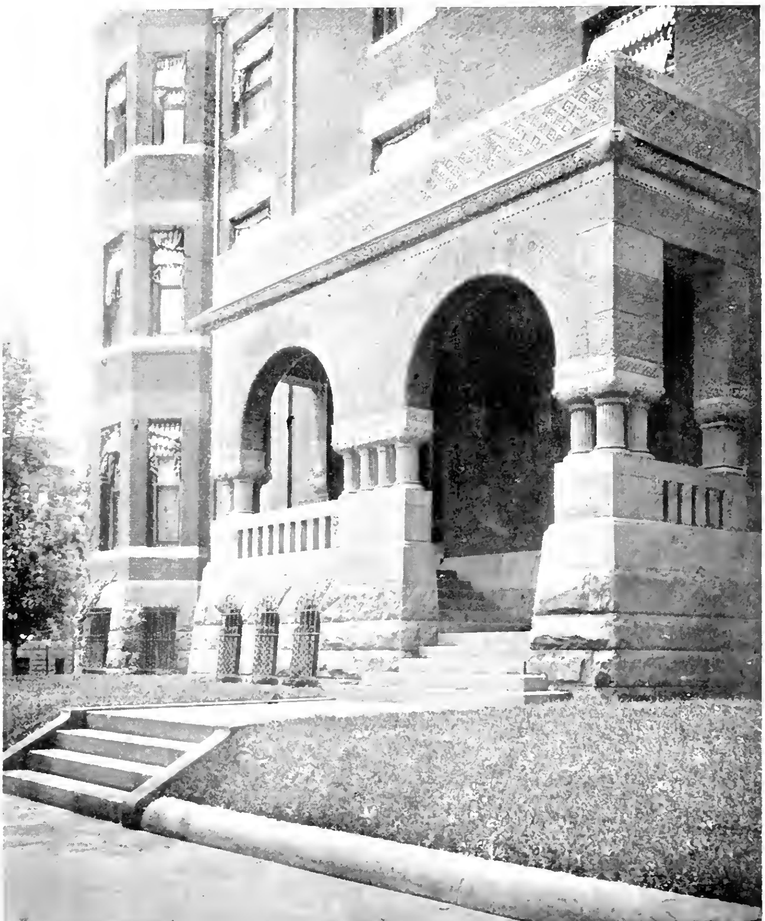
THE FRAZIER RESIDENCE.



THE LEITER RESIDENCE.

Colonial residence, designed without an effort to follow the style strictly. From it several lessons may be learned. In the first place, it appears to be too large for its site; the parking here is slight, and the grandiose appearance of the house seems to call for grounds belonging to it. The building is not well proportioned in its masses, and the roof is deficient in repose. The color is not agreeable, the brick being very light, almost white, with white terra cotta details and red-tile roof.

Washington is, in truth, a beautiful city, charmingly laid out, admirably planned for convenience and effect, and adorned with many large public buildings, many of which have qualities of stateliness and repose, of dignity and of mass, which make them really admirable in their general effect and much superior to many recent buildings. Its



PORCH; SENATOR HEARST'S HOUSE.

PARLOR ; RESIDENCE OF SENATOR HEARST.

HALL IN SENATOR HEARST'S HOUSE.

SENATOR HEARST'S RESIDENCE; THE MUSIC ROOM.

commercial buildings are not yet of first importance in size or in architecture, one or two hotels and office buildings alone disturbing the harmony of general spaciousness and uniformity of altitude. Its public buildings apart, the residences of Washington form the most considerable portion of its architecture. As in every city, these are of varying degrees of excellence; yet many are certainly entitled to rank with the best examples of America buildings in their class.

RECENT IMPROVEMENTS IN GOLD MILLING.

By H. M. Chance.

MANY persons well qualified to analyze existing conditions believe that the movement toward an enlarged output of gold is yet in an incipient stage. This belief is based upon the fact that, aside from those actually engaged in or interested in mining, there are few who as yet realize that the gold-mining industry is passing through revolutionary changes, that the cost of producing gold has been falling while its value has been rising, and that the so-called "boom" in mining has a sounder basis than the discovery of some new and rich gold-fields. Never before in the history of civilization have the environments of the industry been so favorable, never before has the prospect of profitable mining seemed so well assured, as at the present time, and never before have such facilities existed for quickly increasing the output. The facilities are at hand, the incentive is plainly in sight, the activity has already commenced, and the public will soon be forced to modify the old idea that gold mining is merely one form of gambling.

In the present article it is proposed to discuss some of those recent improvements in gold milling which have contributed to the present conditions by lowering the cost and increasing the efficiency of gold-milling processes.

The cyanid process was patented in 1889, and was first applied to practical work on a large scale in 1890. It is estimated that more than 750,000 oz. ($15,000,000) of gold was extracted from ores treated by this process last year. The results achieved by the extension of the chlorination process in the last few years are perhaps even more startling, and the increase in gold production traceable to reduced smelting cost may be estimated at a still larger quantity.

Prior to 1850 the art of mining and milling gold ores advanced sluggishly, development on modern lines being limited to those milling and metallurgical improvements effected in the Cornwall and Austro-German mining districts. The modern gold-mining era had its initial stage in the period of mining activity which followed the discovery of the Californian and Australian gold-fields. Mining in California quickly passed from the hand-work stage of washing stream and bar gravels, with the pan, rocker, long-tom, and sluice, to the hydraulic system, by which the alluvial deposits occupying ancient river beds were worked on an enormous scale and at almost incredibly low cost,—one noted operation showing a net profit from washing material yielding less than three cents per cubic yard. This industry, however, was doomed from its very inception by the inevitable injury to agricultural bottom lands, and the damage to harbors caused by dumping millions of tons of *débris* into the rivers, and was soon crippled and finally killed by litigation.

The period marked by the development of hydraulic mining was one of activity in vein mining also, and many mills were built to treat the free-milling gold ores discovered in California, the American stamp-mill almost in its present form being evolved during this period, while the discovery of the Comstock bonanzas (1865) still further stimulated the development of stamping and milling processes. The second stage of development may be taken as covering the decade from 1865 to 1875.

Prior to 1875 gold mining was generally restricted to those veins of free-milling ore which contained not less than from ten to twenty dollars per ton,—no proposition showing less than fifteen or twenty dollars per ton being considered attractive,—and to veins of smelting or refractory ores showing assay values of not less than thirty-five or fifty dollars per ton. About this time the rush for the rich placer (gulch) discoveries of the Black Hills commenced, and the development of what is now known as the Homestake property quickly followed. It was soon shown that with cheap mining and good mill management ores yielding considerably less than ten dollars per ton could be worked with profit. This, it is true, had already been done in California, but the mining and milling costs at Deadwood, S. Dak., were soon reduced below those at any plant working under conditions fairly comparable to those present in the Black Hills; and, as the mills were increased in size and automatic feeders added, free-milling ore yielding less than five dollars per ton became the basis on which large dividends were earned. Simultaneously with this drop in mining and milling costs, the cost of milling in California was also reduced, and early in the eighties it was generally conceded that any large vein of five-dollar free-milling ore was a good proposition. As this opinion gained ground, it became the basis of a veritable boom in "low-grade propositions," this being the one class of gold properties sought after from 1882 up to about 1892. To it may be attributed the development of the great Treadwell mine in Alaska, profitably working a two-dollar ore, and a large number of mines in this and other countries working free-milling ore yielding less than four dollars per ton.

The possibility of profitably working ores so low in value is always predicated upon a deposit or vein large enough to insure cheap mining, and so located that supplies, fuel, and water can be obtained at moderate cost. It is further necessary that the gold should yield readily to amalgamation (or yield cheaply to chlorination or cyanid treatment), and that it should not require fine crushing or grinding.

Looking backward almost thirty years to the stamp-mill as built in 1868, and comparing it with the stamp-mill of the present time, the improvements are found to relate mainly to matters of detail in construction and design, in strengthening parts found to be weak, substituting materials better adapted to the strains and wear to which the various parts are subjected, and in altering their dimensions, the weight of the stamps, the size and style of cams, tappets, stems, and shafting, and the width, height, and depth of mortar, to suit varying conditions and to increase the capacity and efficiency of the whole. The practical effect of these improvements has been to double the capacity and efficiency, and to reduce the cost of maintenance more than fifty per cent. The addition of rock crushers, ample ore bins, and mechanical feeders has further increased the capacity and reduced the cost of stamping.

The successful working of all low-grade free-milling propositions depends mainly upon the ability of the mill to crush a certain quantity per stamp per day. On ore not requiring crushing finer than to a 30 mesh the output per stamp ranges from 2½ to 5 tons per day, the most successful mills passing from 3 to 4 tons per stamp every 24 hours.

Crushing to 30 or 40 mesh will rarely give as high a percentage of extraction (by simple amalgamation) as crushing to 50 or 60 mesh, and the size to which a free-milling ore should be crushed to yield the largest profit—not the largest gross returns—must be determined separately for each ore. As an example illustrating this problem, we may assume an ore which contains $4 per ton of gold yielding to plain amalgamation, of which 75, 85, 90, or 95 per cent. may be recovered by milling to 30, 40, 50, or 60 mesh respectively; a mill of 50 stamps putting through 4, 3, 2½, or 2 tons per day, according to the mesh used, at a cost of $120 per day total milling expenses; and a mining cost respectively of $1.50, $1.60, $1.70, and $1.75 per ton for 200, 150, 125, or 100 tons daily output,—the problem being to determine to what mesh the ore should be stamped.

Mesh	Tons per Day.	Min'g Cost pr ton.	Mining Total Cost.	Mill'g Total Cost.	Total Cost.	Cost per Ton.	Gold recover'd per cent.	Gold per Ton.	To'al Yie'd	Profit.	
										Per Day.	Per Ton.
30	200	$1.50	$300	$120	$420	$2.10	75	$3.00	$600	$180	$ .90
40	150	1.60	240	120	360	2.40	85	3.40	510	150	1.00
50	125	1.70	212.50	120	332.50	2.66	90	3.60	450	117.50	.94
60	100	1.75	175	120	295	2.95	95	3.80	380	85	.85

Reducing these assumed data to tabular form, it appears that, when crushing to 30 or 40 mesh with only 75 or 85 per cent. saved, the profit per ton would be greater than when crushing to 60 mesh with a recovery of 95 per cent. of the free-milling gold. It might, possibly, be better policy to crush to 40 mesh with a daily profit of $150 (saving 50 tons of ore for future work) than to crush to 30 mesh and obtain a profit of $180 per day, the problem, under such conditions, being resolved into a question of whether the present value of fifty tons of ore left in the ground for future use is more or less than thirty dollars. The principle here illustrated has been the key-note to American free-milling practice, involving the pushing of mine, mill, and management to their greatest earning capacity, with large quantities handled at low cost, correspondingly large aggregate profits, and correspondingly large losses in the tailings. This practice has been carried to the limit, some mills running through a 20-30 mesh as much as 5 or 6 tons of ore per day. American milling practice is thus quite in harmony with modern management at large industrial works, where the "intensive" theory of production is applied by working every machine to its greatest capacity, regardless of ordinary wear and tear.

The excitement born of this species of mining development has subsided, leaving us, however, these well-defined principles, upon which the most profitable method of treating free-milling ores may be predicated, an established record of continuous dividends vindicating the wisdom of those to whose enterprise and ability we owe this knowledge.

Within the last few years the earth has been ransacked for large deposits or veins of ore carrying from three and a half to five dollars per ton free-milling value, and developments now progress slowly because such deposits are not plentiful, and also because veins showing this character at the surface commonly change into sulphid or refractory ores at comparatively shallow depth.

Precisely the same considerations, the same underlying principles, are the ruling factors of present practice in milling and treating refractory ores by the chlorination and cyanid processes. It is not a question of the highest percentage of extraction at the least cost, but of the greatest aggregate profit which a plant or mine can be made to yield; and the selection of the process, the appliances, and the method of construction and management of the plant to so treat the ore as to extract the greatest possible profit, involves considerations similar to those applicable to free-milling propositions, but requires also complete knowledge of the individual peculiarities of the ore, and of its behavior under the various conditions to which it may be subjected.

An important distinction may here be noted between the fields of labor occupied by the inventors of processes and appliances, and manufacturers of apparatus and machinery for extracting gold from its ores, on the one hand, and by the mining engineers and mill-men on the other. The former class are always striving to devise methods and to manufacture appliances for extracting the *largest quantity of gola* from its ores at the least cost ; the business of the latter class is to devise ways and means for so utilizing these methods and appliances as to extract the *largest profit* from a particular ore with the least expenditure of capital. One class has in mind the extraction of gold ; the other, the extraction of profit. This distinction should not be overlooked ; otherwise one may rely too much upon the inventors or manufacturers of milling appliances for advice upon questions which the mining engineer or mill-man is better qualified to consider.

The large capacity attained in present free-milling practice is due partly to the use of narrow mortars and a rapid short drop of the stamp, and partly to the relatively larger portion of the work now done by the rock crushers, and is finally made possible by the use of rather large mesh screens ; successful amalgamation of the gold under such conditions can be traced to the narrow mortar, with moderately high discharge and the use of inside plates.

This construction and method of operation gives every particle of ore small enough to pass through the screens an opportunity of quickly escaping, while, with wide mortars and high discharge, such particles may remain in the mill until repeatedly caught below the stamps and reduced to powder. This construction is also well fitted for working certain special classes of ore, notably those requiring concentration, in which the subsequent treatment is made troublesome by excessive sliming, and to which it may readily be adapted by lowering the discharge and lessening the height of drop ; even when very fine crushing is required, the narrow mortar, with moderately high discharge and short rapid drop of stamps, is capable of doing good work.

In addition to these changes in the proportions of the modern mortar, some minor improvements may be noted which increase its life by the addition of lining plates and increased weight ; but these do not materially affect its efficiency.

The importance of maintaining a uniform height of discharge is generally appreciated, and several plans are in use by which this is more or less rudely approximated,—(1) by removable chuck blocks of different widths, (2) by inserting liners under the dies as they wear down, (3) by placing liners under the screen frame, (4) by making the top and bottom of the screen frames of different widths and reversing the screen, and (5) by placing a board, or two or more strips, against the outside of the screen, to be removed as the dies wear down.

Stamp-mills are better lighted than formerly, more window glass is used, and electric lights have replaced the swinging oil lamps and reflecting lanterns, the tendency being to have all parts of the mill and machinery where they can be plainly seen and easily examined at all times.

Another improvement in mill design is a shifting of the main line of shafting back from the stamps, and in some cases raising it up so that the driving belts run nearly horizontally, thus prolonging the life of the belts, and placing the shaft, bearings, and pulleys where they are accessible and more readily examined.

Another important change is the rather general substitution of gyrating cone crushers for those of Blake style ; this seems justified by the reduced cost and increased capacity. The advantages gained by the tendency to locate crushers at some point outside of the mill (often at the mine), the crushed ore being taken to the mill in dump cars or by conveyors, are : (1) the exclusion of the crusher dust from the mill, with correspondingly increased life of all the mill machinery ; (2) the possible economy in feeding crushers by utilizing labor at the mine or shaft ; (3) the gain of space in the mill, which may be used for enlarging the ore bins ; (4) the elimination of the vibrations in mill frame and machinery caused by the crusher ; (5) the relief from the irregular work and shocks thrown upon the mill engine by the crushers when these are run by belt from the mill shafting.

Another economy recently effected is that resulting from finer crushing of the ore before sending it to the stamp-mill, present practice favoring double crushing by passing the ore through one large and two small crushers.

The improvements recently made in the selection of material for shoes, dies, heads, cams, and tappets are merely such as may be expected from the use of such improved manufactures of iron and steel as may from time to time become available for these purposes.

Much has been done to better the design and arrangement of amalgamating appliances. As a rule, the management of amalgamation is turned over absolutely to the "amalgamator," and, as an incompetent man in this position may cause more trouble than a rebellious ore, a word here as to the professional amalgamator may not be out of place. The amalgamator is too often a tradesman, whose sole capital may be a few years' experience at one or two mills, fortified by the possession of a number of secret formulæ (handed down to him as trade secrets) which he has neither the knowledge or ability to use intelligently. A man of this character can generally be recognized by the air of mystery pervading his work, by his secretiveness regarding any chemicals he is using or the proportions of his mixtures, by his self-confidence (he always knows just how to amalgamate any ore that may be shown him, but invariably declines or fails to say just how he would treat it), and by his ingenuity in blinding those around him to actual results, or in keeping the management on the *qui vive* anticipating the better results, which he is always just on the eve of accomplishing. An intelligent, sober, experienced, honest, and reliable amalgamator is not easily found, especially one with sufficiently varied experience to be of real assistance to the management. Perhaps our mill managers are themselves responsible for this state of affairs; for it often happens that, when such a man is obtained, his very honesty and candor in admitting his ignorance of some things bring about his discharge, and some more reticent, ignorant, and perhaps dishonest man takes his place.

There has been so much charlatanry pervading the whole subject of amalgamation that it is not surprising that managers with a reputation to sustain often prefer to leave the responsibility with their amalgamators rather than to assume it themselves by dictating methods or introducing innovations.

In keeping amalgamating appliances in condition to do the best work on any ore, there are many details which an experienced amalgamator will master better than anyone else, but there are some principles broadly covering this whole field of work which should be formulated and applied by the management.

Perhaps the most important factor in amalgamation is the extent or area of amalgamating surface. It does not seem possible to expose too much surface, and the greatest recent improvement is the tendency to increase both the length and width of the plates; so that from 4 or 5 feet the length of plates has grown to 8, 9, 10, or 12 feet with the full width of mortar from end to end. It is now well established that whatever amalgamation can be effected in the battery should be done there, and the inside plates are, therefore, made as large as possible. The value of the outside lip plate added by some mill-men can be measured by the amalgamated surface it presents. When the pulp, after passing over plates 10 or 12 feet long, carries more free gold or amalgam than good practice permits, it is sometimes passed over other plates (tailing plates), which may advantageously be arranged in steps, with a drop of from one to four inches from plate to plate. The impact of the pulp on the plate is supposed to force small particles of gold into more intimate contact with the plate than results from the undisturbed flow of the pulp, insuring the amalgamation of particles which otherwise might escape. Satisfactory results have also been obtained by making the tailing plates wider than the battery plates,—doubling the width,—by thinning the pulp, and by decreasing the pitch of the plates.

A pulp velocity or impact sufficient to cause a slight scouring of the amalgam, or a mere tendency to scour, when followed by decreased velocity with full surface for re-depositing any scoured material, has been found to increase the extraction. This may result from the scratched, file-like, and burnished condition of the plate at the point of scour, which is doubtless in prime order for a malgamation, and possibly may be caused in part by the mechanical force of impact, by which the film of water lying between the particles of gold and the plate is penetrated, and actual contact of the plate and gold assured. Whether this be the correct explanation of this phenomenon or not is, perhaps, immaterial, for the fact is well established that a portion of the free-milling gold may best be saved with a certain pulp thickness and velocity, while other portions may require different treatment; therefore the most rational and promising method of treating the tailings of such ores is by impact by falling on short plates, followed by wider plates and a thinner and slower flow of the pulp over them. Whatever benefits may be derived from these combined actions are realized, in part, at all mills using plates inside the battery and passing the pulp over outside plates of ample size, for the inside plates present a surface on which the effects of impact and tendency to scour are constantly operative, and the outside plates supply the remaining conditions.

While the possibilities of mercury and amalgam traps and of riffles, following plate amalgamation, in saving mercury, amalgam, and free gold, were worked out many years ago, the cheapening of smelting and extracting processes has recently re-developed and enlarged their field of usefulness, and they are now used at some mills to effect a cheap and crude concentration of the sulphids. In the absence of proper concentrating machinery, the saving of even a portion of the sulphids in this way is an advance on former practice, and in some cases is claimed to yield larger net profits than modern concentrators could earn.

Modern stamp-milling practice has been admirably described and discussed by Mr. T. A. Rickard* in a series of articles published in the *Engineering and Mining Journal* and in the *Trans Amer. Inst. of Min. Engrs.*, 1894-1896, to which the present writer desires to acknowledge his indebtedness for details not coming immediately under his own observation.

In the July issue of THE ENGINEERING MAGAZINE the subject will be resumed and concluded by a discussion of recent improvements and modernized practice in concentration, chlorination, and cyaniding.

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* Other literature covering this subject will be found in the same publications by Prof. H. O. Hofman, Walter McDermott, P. W. Duffield, R. W. Raymond, E. E. Olcott, etc.

MODERN MACHINE-SHOP ECONOMICS.

By Horace L. Arnold.

III.—A MODERN PLAN FOR A MODERN SHOP.

THE ventilated gable roof is the form commonly adopted where the traveling crane is to be used, the ventilator walls rising just outside of the tracks for the crane-carrying wheels. This form of roof is common, also, in buildings not supplied with traveling cranes; the slope of the side roof surfaces naturally guides all currents of heated air to the ventilators, and the pivoted or hinged glazed sashes which form the ventilator sides very effectively aid the lighting, which is never all that is desirable on side-lighted shop-floors.

As the traveling crane must be at a very considerable height above the shop-floor, the side roofs and side walls are often carried so high as to give more than the needful head room over the side spaces not covered by the crane. This enclosed space is unused in the single-floored shop. If the side-wall windows are carried well up, this vacant overhead side space is well lighted, and also well warmed and well ventilated, and at first thought would seem to be an excellent place to fill with light tools and small vise work. Evidently all that is needed is to put in gallery floors reaching in nearly to the space covered by the traveling crane. So obvious are the advantages of this plan that most managers of ventilated gable-roof shops which are not supplied with gallery floors think well of it as a means of increasing floor-space, though but few superintendents who have had a thorough experience with galleried shops are hearty in their commendation. Even where there is a bridge in the middle of the galleries to mitigate in some degree the immensely long travel imposed on the foreman of the gallery floor, it is still a long distance round this part of the shops, and an observer on one of the side floors is too far away from the other side to see what is being done there.

While the gallery is not so bad as full multiflooring, it is, unquestionably far more difficult of access and observation than the single floor. It is a make-shift which imposes great labor on the superintendent who believes that the eye of the master can do more work than both his hands. It interferes with the lighting of portions of the main floor, and wastes a great amount of time and energy. It is a detached space, a foreign territory; and in some cases observed the gallery showed unmistakable signs of that neglect which is the inevitable fate of places reached with difficulty. In the case of single-floored shops having the crane space, side spaces, and the ventilated gable roof, the environment is often such that the gallery is almost the only device available for furnishing needed additional floor-room. But no one who is once made familiar with the single-floored machine shop will ever willingly return to the multifloored or galleried type.

Economy in land cost is urged in favor of whole or partial shop multiflooring. Take a plot 100 feet square, at $200 per front foot; this costs $20,000, or $2 per square foot. Suppose 50,000 feet of shop-floor is demanded, and a five-floored structure is erected on the plot to meet the case: if built to cost less than $2 per square foot of floor, it is undoubtedly too cheap for economy. A space 20 feet wide next to the walls may be well lighted, if the building is isolated; this leaves a badly-lighted space 60 × 60 in the middle of each floor, which must be artificially lighted a great part of the time. One of the largest cycle factories has floors nearly as specified, all of which have practically waste-places in the middle, the foremen and workmen arranging matters so as to make the most use of the light at the sides. In addition to this obvious disadvantage of comparatively unproductive territory, men must walk through or around this unremunerative space; and materials, and work in progress, must increase the length of their journey. Elevators and stairways very greatly reduce the usable floor area. and the most valuable time of men in responsible positions is wasted in the laborious effort to obtain information by personal observation. Indeed, in the multifloored shop the manager generally finds it absolutely impossible to exercise personal oversight: he adopts a policy of dependence on the reports of others; he cannot go to see his foremen or their departments, and hence has his subordinates come to him, and is at their mercy. A foreman must be a man of rare honesty, intelligence, and powers of imparting information, to give his superior an absolutely correct and full idea of affairs in his department. The manager becomes suddenly and unpleasantly aware that he does not know the real state of things in his establishment, and he has either to fight enemies in the dark, or leave his own duties unperformed while he sees things outside of his office with his own eyes. The greatest possible lack in shop management is a lack of knowledge of the real condition of things in the shop departments; and it is safe to say that there is not at this moment a manager of a multifloored machine shop living who has not, back of all his other thoughts, an uneasy sense of this deficiency. This is a condition inseparable from the multifloored shop. All bodies move in the direction of least resistance. The manager, no less than the workman, will try to do his work in the easiest manner; if he has to choose between being on his feet all day outside of his office, thus of necessity neglecting his own especial duties, or sitting in his office and accepting the reports of others, he will infallibly elect to do his own work himself, and obtain his knowledge of shop affairs at second-hand. Of the two evils he accepts the one least distasteful to himself, and falls back on the resolve to have subordinates on whom he can depend.

Returning to the ground cost of $2 per square foot; if the shop had been made single-floored to cover an area of 50,000 square feet, the first cost would have been very little more than that of the five-story shop on the plot 100 feet square. The necessity for expensive foundation and the need of costly fire-proofing disappear together, when the single floor is adopted. Almost any soil will support single-floor loads without special foundation work. Supposing even 100-ton cranes to be installed on ground requiring piling; at a load of 12 tons per pile, only four or five piles need be driven under each supporting column of the crane ways; for cranes up to 50 tons the crane ways are an easy engineering problem. Without cranes, or with such cranes as are used in the Straight Line Engine Shops, where the total weight of the hand traveling crane having a five-ton lift is only two tons, the cost might easily fall below that of the same multifloored area on less land. In this case the fixed charge of realty interest would be the same for both structures. But the first cost of land and buildings is not the most important item, and in any case the buildings inevitably decay and constantly lose in value, while land may, and commonly does, constantly increase in value in manufacturing localities in compound interest ratio, by that very lapse of time which extinguishes building values. Hence, on the face of things, it is economical to put a single-floored shop on a large piece of ground rather than to put a multifloored shop on a small piece of ground.

But it is the cost of labor, not buildings, that chiefly concerns the manager who seeks economical machine construction.

Suppose 50,000 feet of floor surface to work 500 hands at an average of, say, $10 weekly, or $250,000 total yearly wages in a shop costing, say, $2.50 per square foot of floor = $125,000, which, at 5 per cent., gives a fixed interest charge of $6,250 yearly. If the single-floored shop can save 2½ per cent. of this pay roll, it will gain $6,250 = the total 5 per cent. interest charge.

The former shops of Sterling Cycle Works, Kenosha, were in a multifloored building in Chicago, with stairways and elevator. The elevator man was paid $1.25 per day; the general manager therefore placed the cost of running the elevator at $7.50 per week. I believed it was at least $15 per day, from what I had observed in the shop, and Mr. Timm, superintendent, and also designer of the present shop, gave $25 per day as the very lowest extra expense due to the elevator. The general manager had never viewed the elevator question from the standpoint of all costs included, and demurred very strongly. Mr. Timm proceeded to fortify his statement with such details of the work of the current day as made it clear to the manager that $150 per week was a really low estimate. If any manager will make a mental picture of the scene at the elevator shaft on each of the six floors of a busy factory, and trace the course of each truck-load of stuff which comes to the elevator for raising or lowering, he will conclude that the pay of the elevator man is only a very small part of the total labor cost of elevator service. In very recent conversation the Sterling manager asserted that the new single-floored shop made a saving of over ten per cent. in labor cost of production ; he said, also, that the good light and ventilation, absence of stairways, and general convenience of the shop gave them the pick of the workmen, simply because it is easier to work in an agreeable shop than in badly-lighted and inconvenient quarters. Going back once more to the supposititious shop structure, 10 per cent. of $250,000 = $25,000 possible yearly saving due to the shape of the work-floor of the shop, if the Sterling managér was correct in his statements.

Undoubtedly such a conclusion as this is likely to be pronounced an absurdity by many excellent and experienced managers, the first point made being that the management of the Sterling must have been very poor in the old shop and very good in the new. Fortunately the management and the superintendence are the same in the new shop as in the old, throughout. Let any manager take notice of the cost of handling work in his establishment ; let him also take notice of the unproductive labor of the workmen in going up and down stairs, and in walking from one place to another ; let him also estimate at its true detrimental effect the needless labor put on foremen by elevators, stairways, and waste places in multifloored shops ; let him become fully aware of the needed things not done because of the needless doings entailed by faulty and avoidable shop structures, causing faulty lines of shop travel and sequence ; and he will then begin to understand the far-reaching influence of the shape of the shop on the cost of the finished product.

The De La Val shops, designed by Mr. Frederick Hart of Poughkeepsie, N. Y., not only offer all possible advantages in the way of form and light and reduction of superintendent's work, but have the singular feature of extensibility in these directions without tearing down and throwing away any material whatever. As the De La Val shop manufactures only a single machine in different styles and sizes, and is a manufactory pure and simple, having no commercial relations save with the New York headquarters, the shops require only small offices, which are located over very low rough-stock store rooms in a two-floored building totally different in construction from the workshops. This stores-and-offices-building is extensible from either end. The superintendent's office commands a view of the entire machine floor, as that officer sits in his chair at his desk, and a very easy short stairway puts him on the shop floor. The drawing-room is on one side of the superintendent's office, and the book-keeping department is in front of it; for a medium-sized shop, requiring a small office force only, the arrangement is admirable, but the offices are not sufficiently extensive for a machine shop doing a general business.

Supposing a machine shop is to be built in a thickly-populated district on a plot accessible from one side only, can a good arrangement of departments be made, and, if so, can a homogeneous structure be devised which will suitably house both shops and offices? This is a question often asked, and commonly answered in the negative. The accepted alternative is to abandon the town idea altogether, and seek a suburban location, where air and light can be had on the four sides of the buildings. Nevertheless, the problem is not impossible, but, on the contrary, has a rational solution at a very low cost, which perfectly answers all needful conditions, and, excepting in the one particular of approach through squalid and unprepossessing surroundings, can give both workshops and offices of the most desirable character.

Air is the first necessity. There is some place in any reasonably large plot of ground, no matter what its surroundings, where a moderately high air stack will open up into a tolerable atmosphere; at no very great expense the air drawn into the proposed shops through this stack can be washed, dried, and either heated or cooled, as may be needed, before it is distributed through the establishment by blowers. Some rooms in Chicago, where a great number of workers are closely placed and the atmosphere is so vile a compound of dust and smoke as to render satisfactory operation of delicate mechanism impossible, and where nausea, head-ache, and impossibility of concentrated attention were common happenings among the toilers, are now entirely shut up, and supplied solely with washed and dried air, with the most agreeable and economical results. But in most cases it will be enough to take the air in at the top of a shaft of no excessive height. This disposes of ventilation.

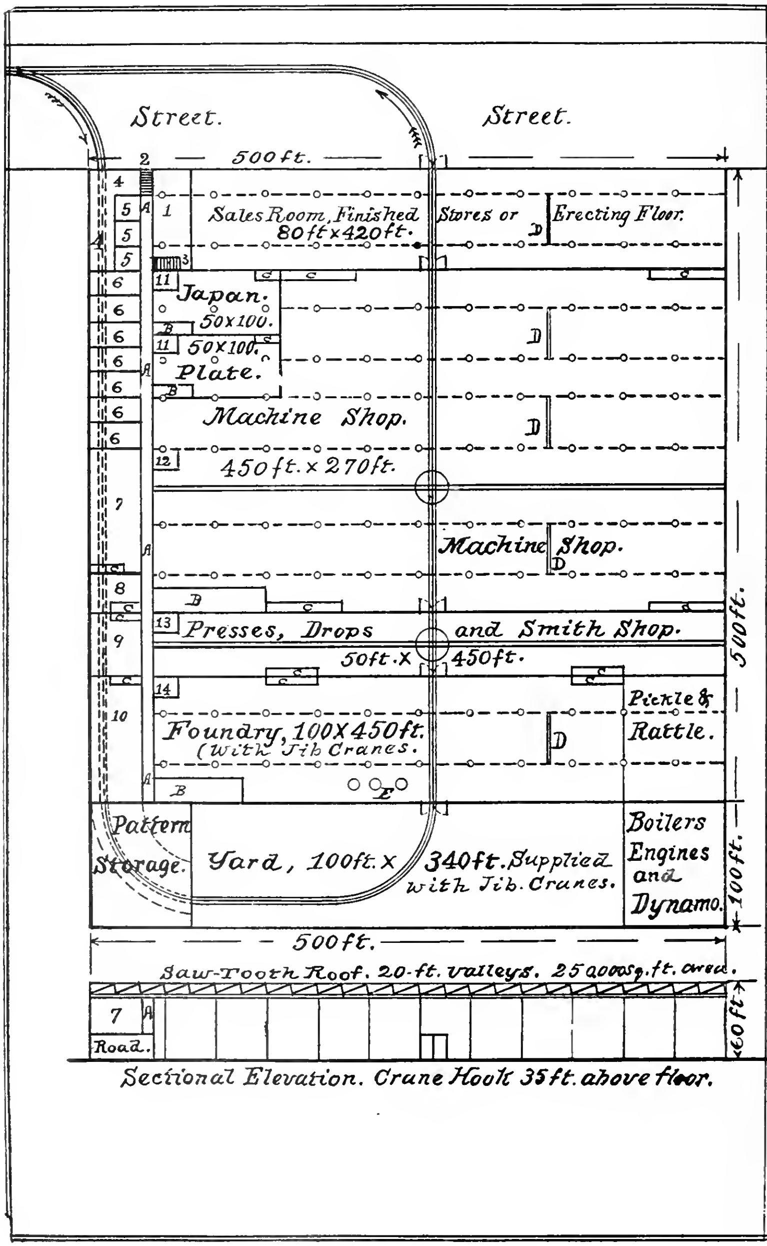
No building of any considerable width can be evenly lighted from the sides in a suitable manner for the machine shop. The top is the only surface of a building which cannot be darkened by the erection of contiguous structures. No one who has never seen a machine-shop interior lighted by the saw-tooth roof can have any adequate idea of the effect of the abundant overhead illumination which it secures. The arrangement of glazed slopes facing the north, and solid roofing toward the south, secures a strong, but agreeable, diffused light, never needing to be curtained, because it is never directly from the sun, and never affecting the eye of the workman unpleasantly, because it falls from above and makes the natural shade of the forehead always effective.

The only real problem connected with the saw-tooth roof is the valley gutter, and this detail has been so fully and simply and cheaply worked out by Mr. Hart in the De La Val building as to make the heaviest snowfall a matter of no inconvenience whatever. The expansion-mounted metal gutter is semicircular in section, and slopes one inch in ten feet, each way from the mid-line, and a steam-pipe running under the whole length of each gutter close to its lowest point assures a clear water-way in the gutter bottom under any possible conditions of snow-load and outside temperature, and also avoids any possibility of drip from condensed moisture on the under surface of the gutters. Such dripping falls upon the steam pipe underneath, and is at once vaporized and absorbed by the air. The valleys of this roof should run east and west, but this makes little difference, as the valleys can run either way of the shop here proposed without inconvenience. With a drainage inclination of 1 in 120 a 500-ft. roof would have a gutter elevation difference of 25 inches; but the gutter system can be divided into any length of individual drainage areas, leaders from the lowest point of each being carried down the crane-way supporting pillars to the subterraneous sewer system.

Since the supposed shop site is accessible from one side only, and since every work-shop should have two clear roads, one for entrance and one for exit, the width of one roadway is taken from one side of the plot, covered by the offices-gallery, and connected by curves or turntables, as the case may require, with a half-length branch in the yard at the end farthest from the one street, to the second roadway, which leads from the yard in the rear through the middle of the shops back to the street again. The margin road is for incoming material, and the middle road for advancing parts of work in progress and shipping finished work: in case, however, of incoming material in the form of heavy casting or forgings, the middle road, which is served by cranes in each division of the shops, can be used for reception. The plot is supposed to be nearly square; if it is very much greater in one dimension, so as to make a long narrow building a necessity, the number of cranes required would be considerably increased, because the proposed design contemplates cranes in all cases traveling at right angles to the middle roadway, so that any piece in crane-served space may be picked up and carried to the roadway; and delivered to the road to be carried to another department or shipped outside. Generally, the space of shop-floor served by cranes need not be, I think, over one-third or one-half of the entire area; but this is a matter of discretion and choice, as the design here suggested permits serving the entire floor, or any desired part of it, with cranes, while the middle road opens heavy transportation between all the crane-served areas with one slinging only. The margin-roadway is wholly enclosed for the length of the building as it runs beneath the offices, drawing and experimental rooms, and pattern shop. The pattern storage-room should in all cases be a detached fire-proof structure, in the yard, adjacent to the foundry, and connected therewith by a covered way having two floors, one leading from the pattern room and one from the foundry.

These conditions immediately determine the arrangement of the gallery departments over the marginal roadway. The pattern shop is in the extreme rear, next to the yard and pattern store-house, and next to the foundry; next to the pattern shop comes the model and experimental room, in case this department is put on the gallery floor; next the drawing-room, and then the office of the mechanical engineer, that of the general superintendent, and still outward toward the street the book-keeping, with the weighmaster over the roadway in front, and the business manager's departments also in front. The department foremen have their offices at the department entrances, which are from the margin road, with wash and locker rooms for their own men opposite, and elevators and speaking-tubes from each foreman's room to the gallery floor. This brings the superintendent within a few minutes of every official in the entire establishment, and affords any official facilities for visual observation of everything under his charge which are not present in any previous workshop design within the knowledge of the writer. As shown, one-third of the floor is covered by cranes, the spaces between the rows of crane-supporting pillars being twice as wide as the crane length. The heavy hammers are farthest away from the gallery, so as to interfere as little as possible with the drawing-room and the pattern room. Work in progress travels from the yard, the foundry, and the smithy toward the street, and the show-room for finished work and customer's reception-room and business offices are on the street.

The writer has not the vanity to claim perfection for this shop design; it is put forward, as was stated at the outset, as a composite design wholly made up of features from actual practice, grouped in a manner to meet the obvious needs of an industrial structure of considable extent. In case of only partial construction at first, the building would begin at the line of the yard, perhaps with the foundry and smithy in one division, and the machine shop in the next, with only



PLAN OF THE PROPOSED SHOPS.
For explanation of figures, see next page.

part of the pattern storage-house; and the buildings could be extended, as desired, toward the street, up to the full size of the plot. The unused space in front of the partial shops could be kept up, as at the Link Belt Engineering Shops, Chicago, in ornamental form with lawn and flower-beds, at small expense, amply repaid by favorable effect upon the first impressions of visitors, and upon the spirit and personal conduct of the workmen. Nothing is more conducive to the elevation of the mental standards of employees than an object-lesson of this kind in their immediate environment. Until our advancing civilization brings an increased appreciation of the intrinsic value of beauty, it is sufficient to suggest that, within reasonable limits, it is a factor of sound practical business policy.

A better external architectural effect is secured, if the side walls are carried up to conceal the unpleasant exterior effect of the saw-tooth roof. The engine-room may be placed in the yard, to balance the pattern storage-building. The power transmission may be by wire to motors driving short or long lines of shafting carried by the crane-supporting pillars, or by separate shaft supporting structures, as in the Gates Iron Works, or by individual tool motors, as in the Baldwin wheel-room.

While disclaiming all assumption of originality, the writer ventures to hope that this proposed form of industrial structure will be received as an assemblage of good features of late practice worthy of consideration by intending builders.

REFERENCES TO SHOP PLAN ON PAGE 476.

1. Sales and shipping offices; 30×80 ft.
2. Stairway from street to office gallery; 20 feet rise.
3. Stairway, office gallery to sales and shipping; 20 feet rise.
4. Weighmaster and bookkeeping; 80×20, with "L" 20×20 ft.
5. President's offices, 3 rooms, each 20×20 ft; communicate with each other and gallery "A."
6. Separate offices, 20×40; open on gallery "A."
7. Drawing room, 40×100; open on gallery.
8. Test and analysis, 30×40; open on gallery.
9. Model and experimental room, 40×50; open on gallery.
10. Pattern shop, 40×100 ft.; open on gallery and to pattern storage house, 80×100 ft., 3 floors, fireproof.
11. Japan and plate foremen's offices, 15×20; elevator to gallery A; lift 20 ft.
12. Machine floor foreman's office, 15×20, elevator to gallery A; lift 20 ft.
13. Press and hammer room foreman's office, 15×20, elevator to gallery "A"; lift 20 ft.
14. Foundry office, 15×20; elevator to gallery.

A. Office floor or gallery corridor 10 ft. × 500 ft. Glass partition overlooking shops on right hand (north) side; communicates with all offices and gallery rooms, and runs from the street to the pattern storage house. The gallery floor forms the roof of the in-road; 20 ft. clear above road way.
B. Wash room and lockers.
C. Closets.
D. 40 ft. span traveling cranes, high hook 35 ft. above main floor.
E. Cupolas.

THE ELECTRIC VERSUS THE HYDRAULIC ELEVATOR.

By Wm. Baxter, Jr.

THE electric elevator proper—that is, the self-contained elevator machine—came into use about seven or eight years ago. For three or four years previous to that time ordinary stationary electric motors had been installed in factories and warehouses to furnish power for operating freight-elevators ; but in all such cases the common type of power elevator machine driven by belts was used.

The real cause which led to the development of the electric elevator motor is perhaps not generally known. The general impression is, no doubt, that inventors saw a demand in that direction which, if satisfied successfully, would yield a large reward , and that they, therefore, set themselves the task of solving the problem, and persuading elevator builders to manufacture their machines. This conclusion, however, would be just the reverse of the facts ; it was through the efforts of elevator builders that inventors took up the subject.

How this came about can be briefly explained.

Twenty-five or thirty years ago few buildings of more than five stories were erected, and elevators were looked upon as a luxury, not as a necessity. With the advent of high buildings with fast-running elevators, conditions were changed. Men who a few years previous thought it no hardship to climb up four flights of stairs moved into the new structures where stair-climbing was unnecessary. As a result, the owners of the older structures found that they would have to reduce their rents, or introduce an elevator. The latter expedient was adopted in many cases, but there were many others where it could not be, either on account of lack of room for the installation of a hydraulic-elevator plant, or because the cost of operation thereafter would be more than the revenues of the building would warrant.

This was the situation about twelve years ago, and the elevator builders were compelled to contemplate the fact that there were hundreds, if not thousands, of buildings in most of the large cities that would install an elevator at once, if they could only get something that would not cost more to introduce and operate than the rentals would permit. The fact that they were unable to meet the requirements in these cases with their hydraulic apparatus led them to consider the possibility of finding a solution of the problem in some other direction ; and, as the practicability of the electric motor had then been demonstrated, it was natural for them to suppose that it could be adapted to elevator purposes in a compact, efficient, and durable form.

At the request of several of the officials of one of the large corporations in the elevator field, the writer took up the subject in the summer of 1884, and designed an electric elevator, as well as several arrangements for electrical control of the motion of the car. These officials were very enthusiastic upon the subject, and anxious to start the manufacture of electric apparatus at once; but the president did not believe that the time had come for such an innovation. A few months later, the writer embarked in another branch of the electrical field; but the officials of the elevator company, who believed in electricity, continued to advocate it, and with such success that they soon began to experiment in that line, and in 1888 brought out an electric elevator, which was, perhaps, the first practical self-contained machine placed upon the market.

From the foregoing it will be seen that the electric elevator came into use through the efforts of hydraulic-elevator builders, whose object was to develop an apparatus that could supply a demand for which the hydraulic was not adaptable. Soon after this the various manufacturers of hydraulic elevators entered the electric field, not so much because they believed in it as to keep abreast of the times.

About five years ago new corporations, organized for the purpose of building electric elevators, began to come to the front, and to-day there are a number of such concerns, of which two at least are doing a very large business.

The manufacturers of hydraulic elevators have never looked upon the electric as a real competitor, but have considered it as a valuable adjunct adapted to small buildings, where space is limited, and where the cost of operation of a hydraulic plant would be abnormally high; they insist that for large buildings, where a complete power plant must be installed, and where the very best results are required, not only in economy of operation, but in perfection of control, smoothness of motion, etc., the hydraulic is the best, and is in no danger of losing its supremacy. Those who are engaged in the manufacture of electric elevators exclusively maintain of course that their system is the best under all conditions and for all purposes; that it is not an adjunct to the hydraulic, but a direct competitor of the most formidable kind. Judging from the results achieved within the last few years, the latter claims are not without foundation, and theoretically they appear to be unassailable. It would be contrary to the facts, perhaps, to say that at the present time the electric elevator is equal in every respect to the hydraulic, for, in the matter of certainty of control, the latter is undoubtedly superior. But it is possible for the former to be made equal to it in this respect, inasmuch as the difference is so small that it can be noticed only by an expert. In other directions the electric is superior even to-day. Therefore, if we compare the advantages and disadvantages on both sides, the probabilities are that the scales would be turned in favor of the electric elevator.

An investigation of the main features of both systems will serve to show their relative merits more clearly.

In the hydraulic system steam pumps are used to force water into a pressure tank, from which the hydraulic cylinder that actuates the elevator is supplied. In a complete electric system a steam engine is used to drive an electric generator that supplies the electric energy for operating the elevator motors. We have the efficiency of the steam pumps and the hydraulic transmission and transforming apparatus in the former case, to compare with the efficiency of the steam engine and electric generator, and that of the electric transmission and transforming apparatus, in the latter. As is well known, the efficiency of steam pumps of the size and kind used for elevator work is much lower than that of steam engines of the same size; therefore, the unit of energy delivered to the water pipe by the steam pump will cost more than that delivered by the electric generator to the line conductors.

The loss in the transmission and conversion of energy, in the hydraulic system, between the pump and elevator car cannot, without the use of very expensive piping, be made as low as the loss between the generator and elevator car in the electric system. From this it follows that the cost of energy delivered to the moving car will be lower with the electric system. As an offset to the evident advantage of the electric system, as shown in the foregoing, it is pointed out that, in the hydraulic system, the pressure tank acts as a storage reservoir of energy, and that, owing to this fact, the pumps can be made to work at a more uniform rate, and at an output that more nearly approximates the point of highest efficiency. This claim is based upon the fact that the energy required to operate an elevator car is variable within wide limits; the greatest demand is made at the instant of starting with the maximum load, and from this maximum the demand reduces to zero when the car is not in motion. As the capacity of the pressure tank is several times that of the hydraulic cylinder, it is not necessary for the pump to be of sufficient capacity to equal the maximum demand, as any excess of energy drawn at such times can be compensated when the demand falls below the pump capacity. It is evident that, if the pressure tank is large enough, the pump can be made of a size equal to the average amount of energy required to operate the elevator, and that it can work uniformly at this rate. The tanks are never made so large as to fully realize this condition, but they approximate it closely; therefore the pumps can be operated at a point very near to that of the highest efficiency.

As the electric elevator has no storage device, the engine must be of such capacity as may be necessary to meet the maximum demand, and, as this is far above the average, the defenders of the hydraulic system claim that it reduces the actual efficiency of the steam engine to about the same level as that of the pump, owing to the fact that the average output of the former is far below the rate of highest efficiency.

This assumption would hold good, if only one elevator car were used ; with two cars, the difference between the average and the maximum demand would not be so great, as both cars would not require the maximum supply at the same time. As the number of cars is increased, the difference is reduced, and, with a plant of, say, six or more, the difference between the greatest and the least demand foı energy would not be great ; so that an engine capacity slightly in excess of the average would meet the requirements perfectly. It is, therefore, evident that, in large installations, the hydraulic system cannot offset the higher efficiency of the electric by reason of the storage capacity of the pressure tank, because in such cases the average and maximum demands for energy are so nearly equal as to eliminate the advantage of a storage capacity.

With an elevator plant of five or six cars, or more, there can be but little doubt that the cost per unit of energy delivered at the car will be lower with the electric system ; therefore, the total cost of energy will be less, even if the same amount is used in both cases. But, with an electric elevator of the drum type, the energy required to perform the same service can be made much less than would be required with a hydraulic elevator. This is due to the fact that, with the former, the weight of the car can be overbalanced, and, if the excess of weight in the counterbalance is made equal to the average load, the energy required will be equal to the frictional resistance plus the amount absorbed in accelerating the unbalanced weight. When the car is overbalanced, the actual weight that has to be lifted can be made much less than when the load is underbalanced. For example, suppose the car weighs 2,500 pounds and the balance-weight 1,800 pounds; we then have 700 pounds of unbalanced weight. Suppose the average weight of passengers to be 1,000 pounds ; then the total load would be 1,700 pounds. Now, if we increase the balance-weight to 3,500 pounds, it will overbalance the car 1,000 pounds, and thus just balance the weight of passengers, making the actual load zero. In the case of the underbalanced car, the energy required to move the load would exceed that required with the overbalanced car by the amount necessary to raise 1,700 pounds at the velocity with which the car travels.

The energy absorbed at the instant of starting an electric elevator is very much greater than that used when the normal velocity is attained, and this fact has led many to believe that, as stops have to be made at most of the landings, the average efficiency would be considerably cut down. But this is not necessarily so. Part of this excess is lost in the resistance introduced into the electric circuit to keep the car from starting off with a jump, and part through the inefficient action of the motor when the velocity is so near zero; but another portion is absorbed in producing a high rate of acceleration. The first two losses are absolute, but they are of very short duration; the last loss is only partial, because, if the rate of acceleration is greater, the maximum velocity will be attained sooner, and, therefore, a lower maximum is compatible with the same average velocity. From this it follows that a trip from the ground-floor to the top of a building can be made in the same length of time with a lower maximum velocity, and therefore lower maximum expenditure of energy. Hence the gain in this direction will go far toward offsetting the loss in starting.

There is another fact that contributes to the higher efficiency of the electric elevator which is very generally overlooked,—namely, that the hydraulic cylinder must be of sufficient capacity to start the car with the maximum load at a fair rate of acceleration; therefore the energy used at all times per unit of distance traveled by the car is equal to that absorbed at the time of starting.

At the present time the tendency is to increase the speed of elevators, owing to the fact that the height of buildings is constantly increasing With higher velocities the weight of counterbalance in hydraulic elevators must be reduced,—that is, if an independent counterbalance-weight is used. If the hydraulic cylinder is vertical, the counterbalance may be placed on top of the piston, or on the cross-head; but this is objectionable, on account of the enormous weight, required by the fact that the velocity of the car is at least ten times as great as that of the piston. In the majority of cases the cylinder is horizontal, and an independent counterbalance is used. If the velocity of the car is low, the counterbalance may be equal to seventy-five or eighty per cent. of the weight of the car; but, with high velocities, it will have to be considerably reduced, in order to avoid accidents by sudden stops on the up-trip. To illustrate this point, suppose we take the case of a car ascending at a velocity of seven feet per second. If the motion of the lifting ropes were arrested instantly, the distance through which the car would rise before coming to a state of rest would be equal to the momentum divided by the retarding force. If the car were unbalanced, the distance would be equal to the space through which it would have to fall to attain a velocity of seven feet per second under the acceleration of gravity, and this would be about nine inches. If the car weighs 2,500 pounds, the counterbalance 1,800 pounds, and the ropes 400 pounds, the distance through which it would rise, when half-way up the building, would be about 4.8 feet, and, when near the upper landing, about 7.5 feet. Now, an electric elevator, balanced from the drum, will act as if not balanced at all, because the counterbalance-weight does not act directly upon the car. Therefore, if the motion of the ropes were instantly arrested, the car would continue in its upward course nine inches further, and slack up the ropes to that extent. This would do no serious damage, if suitable guards were provided to keep the ropes from jumping off the upper sheaves. If the counterbalance ropes run directly to the car, the distance traveled at the top of the building would be as great as 7.5 feet, and, as the car would drop back this distance, unless caught by the safety catches, the results might be very serious.

From the foregoing it follows that, if very high velocity is attempted with cars counterbalanced directly, the weight of the latter must be very much reduced to insure safety; and this means that the efficiency, as compared with machines of the drum type, will be reduced with an increase in velocity. It may be said that, as the elevator generally carries a load, the distance through which it would rise by the force of its acquired momentum would be less than stated above; but it very often happens that only one passenger goes to the top landing, and in such cases the movement would be about as above stated.

I have said that in certainty of control the electric elevator is not equal to the hydraulic. This fact can be easily seen from the following. The motion of a hydraulic elevator is controlled by the movement of the valve through which the water enters the cylinder. As water is practically incompressible, it follows that the car will stop the instant the valve is closed. If the elevator-operator moves the valve at a rate that will close it while the car is traveling, say, three feet, a stop will be effected in this distance, whether the car is running fast or slow. In order to avoid too violent a stop, the hydraulic cylinder is provided with a release valve, through which the water may escape, should the main valve be closed too quickly. But this valve seldom comes into use, as a very little experience enables the operator to tell how fast to close the main valve. As the speed begins to reduce from the moment the valve is moved, it drops to an almost imperceptible motion when the landing is reached; then a final movement closes the valve entirely, and the car stops just at the desired point.

With an electric elevator the conditions are very different; the car is stopped either by the resistance of a friction brake, or by converting the motor into a dynamo, for the time being, or by a combination of both these means of retardation. If these resistances were constant under all conditions, the distance in which the car could be stopped would increase with the velocity and the load; but, as it is often necessary to make a quick stop when the car is running at a high velocity, these resistances must be variable. The various manufacturers resort to different means for accomplishing these results, but, from the very fact that the friction of a brake is variable even under practically the same conditions, its retarding action cannot be depended upon to be always equal to the requirements. The dynamic action of the motor is more reliable, but there is, nevertheless, a lack of absolute certainty of action. For these reasons, the control of electric elevators, as now made, is not so positive as that of the hydraulic, but further improvements will no doubt make them equally so. The difference in this respect, as already stated, is so slight that only an elevator expert can detect it, and, if the operator has had sufficient practice with the car, he can control its motion in a manner that is highly satisfactory.

While the controlling devices of an electric elevator are not so positive in their action as those of the hydraulic, they render possible the elimination of the objectionable hand-rope. In nearly all the hydraulic elevators now installed, the hand-rope is moved by a wheel or lever of some kind. This is an improvement on the old process of pulling directly upon the rope, and enables the operator to control the car with greater certainty; but it is crude when compared with an electric controlling system, in which nothing is visible in the car but a diminutive switch-box.

As the movements of the elevator car in an electric system are effected by variations in the direction or strength of current, the cumbersome hand-rope can easily be dispensed with; but up to the present time only one company appears to have adopted an electrical controlling system exclusively. At first sight this problem would appear to be very simple, but close investigation will show that it presents many difficulties. Competition, however, will no doubt compel all to abandon the hand-rope in the course of time.

As to the prospects of the two systems, there can be but little doubt that those of the electric are the brighter. While the advocates of each may continue to struggle for supremacy, certain causes beyond the control of either may finally turn the scales in favor of electricity, and leave it in undisputed possession of the field. In large buildings, heretofore erected, it has been customary to install an electric-lighting system, the reason being that, as the hydraulic-elevator plant required a battery of boilers, it was a simple matter to enlarge this somewhat, and add a steam engine and electric generator to the already extensive installation; in this way the lighting is obtained at a cost only a trifle greater than that of the extra coal consumption. This is true where a hydraulic elevator plant is installed ; the running expenses, as well as the amount of machinery with which the building is encumbered, are not increased very much by the addition of the lighting plant. But the advent of the electric elevator has rendered it possible to view the subject from a different standpoint. The electric-elevator advocates say that an electric power plant to operate elevators as well as lights would be more economical and simple than two distinct plants, one hydraulic for the elevators, and one electric for the lights. But would it not be still more simple to discard the power plant entirely, and obtain current from the street-mains for elevators and lights as well ? It may be said that the charges made by the lighting company for current would be much greater than the cost of generating it on the spot. This would be true with a very large plant, but would not be true with a small one. Just where the dividing line would come, where the two methods would be of equal cost, it is difficult to say, as it would depend upon conditions peculiar to each case. But, even if the current from the street mains should cost more, it would in many cases be preferred, on account of its doing away with all the machinery with which the lower part of the building would otherwise be encumbered. That this view of the subject has been taken in many cases is demonstrated by the fact that a number of large buildings have been erected within the last year or two, in which this course has been followed. Thus it may be that for this reason alone the electric elevator may eventually drive the hydraulic out of the field, regardless of whether it is more economical, when a power plant is installed, or not.

In conclusion it may be said that a full consideration of the various designs of electric elevators that have been proposed, or even of those that have actually been made, is not practicable in a short article ; the discussion, therefore, has been confined to the drum machine as it is the kind made by prominent builders with but a single exception. Several other types have been tried, and one of these, the horizontal screw machine, has obtained considerable prominence, owing to the fact that it has been used in nearly all the most important installations with highly satisfactory results. The manufacturers of this machine, although makers of drum machines as well, regard the screw type as the best. If their belief is well founded, it will become the standard machine of the future, but at the present time the drum type is used not only by all the prominent builders, but also by the numerous smaller concerns ; therefore it must be considered the typical electric elevator of to-day, and the proper one to use as a basis for comparison.

BANK REVETMENT ON THE MISSISSIPPI RIVER.

By H. St. L. Coppée.

IF, upon a sunny day, one could occupy an observation station well above the surface of the earth, over the center of the Mississippi valley, and could look with magnifying eyes on the objects beneath, far to the north he would discern a small bright spot of water, from which emerges a winding crystal stream, tracing its course by plain and forest, over shoal and rapid, ever increasing in strength and volume till it reaches the prairie's level. Through the heart of the continent he would trace this river, flowing on until, with the mingled waters of the Missouri and Ohio, draining nearly a million square miles of territory, it emerges from its limestone bed to creep like a great yellow snake through the broad alluvial plain which, since prehistoric times, has been built up from the paving of cenozoic shells once underlying the ocean. In its lower reaches he would see it ever winding through seemingly endless chains of curves, taking from the crumbling bank its load of earth and vegetation, destroying plantation and village, until with its work completed it passes the narrow portals of the gulf, and deposits its burden in the depths of the sea.

At the present time the Mississippi river in many places presents much the same appearance that it did over three hundred years ago. As DeSoto saw it, we see it in some of its reaches to-day, but a civilized nation has replaced the naked nomads of the discoverer's time; prosperous cities occupy the sites of primitive forts, and powerful steamers navigate the ever-changing channels, carrying the rich products of field and mine to be distributed in the markets of the world.

With the change from savagery to civilization came the necessity of controlling this mighty river that poured over field and forest during the spring and summer flood, and in the fall and early winter crept between sandy bars with insufficient depth for navigation, at all stages destroying and building, constantly expending its force to the detriment of riparian owner and navigator.

The Mississippi, in its lower reaches, from Cairo to the gulf, is purely an alluvial stream, flowing through a low-lying land subject to overflow. Its high-water season may be approximately stated as continuing from February to May inclusive, and the low-water season from September to December, the other months of the year marking the transition periods. Its numerous bends have no uniformity of radius or depth, each, with its accompanying bar on the convex shore, terminating in a shoal or crossing where the curve is reversed and the water cuts through the continuous chain of sand.

The banks are formed of strata of sand, buckshot,* and clay, of varying thickness. During the high stages the water scours the bank on the concave side in the bends, depositing the material thus obtained on the bar. At low water the reverse is the case to a great extent; the bar is scoured, and the caving in the bend is materially reduced.

There are, generally speaking, two methods for the improvement of alluvial streams,—canalization and regulation.

The former, owing to the greater cost and difficulty of obtaining permanent foundations for locks and dams, is rarely resorted to, though in latter years the use of concrete has enlarged its field of possibilities.

Regulation includes two distinctive features in streams subject to overflow,—the improvement of the high-water channel and the improvement of the low or medium stage channel. In general American practice, the former consists in the construction of levees and high-water cross-dikes, and the latter in revetment and spurs for bank protection, permeable dams and training walls, sills, and dredging.

The great discharge of the lower Mississippi, the excessive oscillation of its water surface from high to low gage, the vast destructive energy expended in its flow, and the crumbling or friable nature of its banks make the problem of its regulation or improvement for the protection of property and benefit of navigation a very difficult one.

The earliest work of improvement consisted in the construction of dikes or levees to keep the flood water from town and plantation, the first of these being built at New Orleans, in the early part of the eighteenth century. It was from four to six feet high, with a crown of eighteen feet, which was used as a roadway, and was constructed of earth taken from the surface of the ground near by.

From year to year this artificial bank has been extended. Isolated levees enclosing plantations and villages have been joined to it, until there has been developed, little by little, the great levee system that will soon extend from Cairo to the Gulf, protecting nearly thirty thousand square miles of the rich lands of Missouri, Arkansas, Mississippi, and Louisiana, and guiding the floods in a permanent high-water channel to the sea.

With the exception of the constant addition to the levee lines and some tentative dredging operations at the mouth, no important work was undertaken, until the question of permanent improvement of the passes was agitated, culminating in the construction of the mattress and concrete jetties by Mr. Jas. B. Eads. As these structures were built for

* Buckshot is a black clay that resembles buckshot when in small pieces and dry.

the purpose of forming new or artificial banks rather than the protection of those existing, they will not be considered in this paper, nor can space be given to methods of improvement by means of cut-offs and outlets for relief at high water.

Stated in a few words, the plan adopted for the Mississippi has been as follows:

First, to control the flood by levees:

Second, to contract to a normal width the wide reaches by permeable dikes;

Third, to protect the banks from caving, thus making them permanent by revetments:

Fourth, to reduce the high crossing at low water by dredging.

The purpose of the revetment is to prevent the caving of the bank, and thus reduce the load of sediment that is constantly building the bar below; to maintain a normal width in the bends; to protect valuable property resting on the immediate shore; and also to prevent outlets and cut-offs, and the resulting change in the position and flow of the river.

The caving is of two kinds,—that caused by abrasion, and that caused by the combined action of seepage water and the undermining of the foot of the slope by the current, termed sloughing. The degree and rapidity of caving is governed by the material in the bank, the curvature of the bend, and by depth of channel, slope and velocity of river, and land drainage.

Brush and stone revetments have been used for many years in Europe and Asia for the protection of river banks, the custom being to employ, if possible, the material found in most abundance and procured most economically in the immediate vicinity.

The materials used for bank protection on the Mississippi are principally live willows 25 feet long by 2 to 4 inches in diameter at the butt; poles of live cotton wood or willow 25 to 30 feet long by 4 to 6 inches in diameter at the butt; rock in pieces from 10 to 100 pounds in weight, also spalls; spikes 8 to 10 inches long; No. 12 galvanized wire; manila line and wire cables of varying sizes; iron rods, hardwood pins, shackles, clamps, etc. Eight hours constitute a day's work, and the labor is paid at the rate of $1.00 to $1.25 per day, including subsistence.

It must be borne in mind that, though these structures may be similar in general form and construction to those employed on other rivers, their dimensions and the conditions under which they are placed are vastly dissimilar. No revetment work in the world approaches the magnitude of that undertaken on the Mississippi. Here mattresses with a superficial area of seven and eight acres are sunk to

BANK NEAR GREENVILLE, MISSISSIPPI, JUST BEFORE CAVING.

A CAVING BANK, GREENVILLE, MISSISSIPPI.

the bottom of the river in depths of 80 and 100 feet and in currents from 5 to 8 feet per second. Dikes 430 feet long by 60 feet high, each containing 80,000 ft. of lumber, 2,000 tons of rock, and nearly 20,000 pounds of iron (wire, rods, and nails) are similarly placed in 150 feet of water.

The early revetment work, which was purely for the protection of property in harbors and not for the general improvement of navigation (as, for instance, at New Orleans from 1878 to 1881), consisted of piles driven in pairs 6 feet apart along the bank, to which were fastened, by big iron rings, light mattresses 2 inches thick by 25 feet long and 24 feet wide, made of fish-pole cane sewed together by weaving double wires and afterwards yarn under and over them. These small mats were first fastened together, forming sections 200 by 24 feet, and then sunk with iron weights. These mats were of little permanent value. They cost from $12.87 to $7.22 per square (100 sq. ft.).

Another early revetment instanced by the work at Delta Point, opposite Vickburg, consisted of mattresses built of willow brush and laid in cross-layers with top and bottom grillage of poles fastened together with hard-wood pins, No. 10 wire. These mats were constructed on floating ways (a barge with inclined skids), and were 50 feet wide, 150 feet long, and 2 feet thick. When finished, they were launched into the river, and sunk with the long axis normal to the bank by throwing stone on them from small barges. One of these mats could be made and sunk in one day with the untrained labor then employed. Their cost per square was $12, and per lineal foot of bank protected $18.

A modification replaced the grillage of poles and the connecting pins by a wire netting. This netting was formed on a drum attached to the weaving barge or ways, and on it was placed the brush, and, above the brush, wires which were connected through the mat, forming a very compact and strong revetment, some of which lasts to the present day.

The work thus far described is submerged; it was placed in the low-water season, and, after being sunk, remained constantly under water.

It was at first supposed that protection below the low-water line would secure the upper portion: but it was found that the upper bank quickly washed down, and in many places the mats were flanked by the current. In order to prevent this destruction and make the revetment complete and effective, the upper portion of the bank was graded by hand, and on the slope was placed a shore mat built of grillage and brush, bound by hickory pins and wire, covered with rock, and connected at the water-line with the sub-aqueous work.

BALLASTING WOVEN MAT PRIOR TO SINKING.

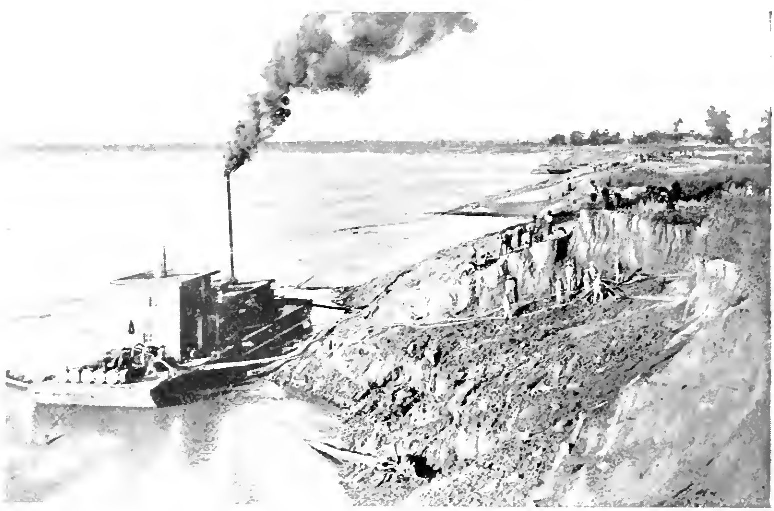
SINKING A WOVEN MAT.

With the promotion of river and harbor work the duty of revetments was materially extended: instead of protecting harbor fronts in limited spaces, they were employed to retain the bank in long and difficult reaches. To meet these new conditions an entire change in construction was necessary. The woven mat was adopted, and con-

MAT SINKING; THE FINISH.

tinued to be the standard for many years, and many localities were permanently and successfully protected by it.

It was constructed by first building on floating ways a rigid head of poles, to which weaving poles were fastened at right angles. On these weaving poles, extended to the full length of the mat, was woven willow brush. A grillage of poles was fastened to the top, and, after being secured to the bank and mooring barge, the mat, 400 feet long by 150 feet wide, was sunk by means of rock thrown from barges.



SLOPING THE UPPER BANK WITH HYDRAULIC GRADER.

After sinking the mat, the upper portion of the bank was graded to a slope (3 horizontal, 1 vertical) by the hydraulic method. The grader consisted of a large duplex compound pump, with a capacity of 2,000 gallons per minute, giving a water pressure of 160 pounds with a steam pressure of 80 pounds per square inch and a vacuum of 26½ inches. It rested on a house barge. The hose from the pump terminated in a 1¼-inch nozzle, from which the water was directed against the bank, reducing it to the required grade. The excavation of one cubic yard of earth took a fraction less than one cubic yard of water, and used three pounds of coal.

DETAILS OF HYDRAULIC GRADING.

Owing to the heterogeneous consistency of the bank, the slope, as left by the hydraulic grader, was often very unsatisfactory and rough. This had to be remedied by hand, sluice, and scraper dressing, before revetting. The height of bank graded averaged about 30 feet, and the material excavated per hundred feet about 3,500 cubic yards, costing about 4 cents per cubic yard for removal.

When the bank was dressed, a revetment of two layers of brush with pole grillage above and below, fastened with wire and spikes, was placed thereon and well covered with stone.

This type of bank protection, with numerous modifications, has

FINISHED BANK WITH POLE GRILLAGE AND STONE PAVING.

been used up to within a few years, and has proved in many places very successful. The size of the mattress was considerably increased, being as much as 2,000 feet long and 300 feet wide. The thickness was also increased by overweaving and cross-weaving, and the additions of loose brush under top grillage. Greater strength was obtained by the introduction of iron rods, longitudinal and transverse cables, and hard-wood heads. In the early and insufficient work the cost per lineal foot of bank protection was $14; the later standard-woven mats, 300 feet wide, with paved bank, cost $30.

Notwithstanding the fact that additional strength and thickness had been given the woven mat, it was found that the water would scour the bank through the spaces between the willows, and, owing to its stiffness, the mat was often damaged at the outer edge where the action of the current was most violent. To prevent this, and to obtain a structure both stronger and more pliable, the fascine form was tried, and proved so superior to the old mat that it has been adopted as the standard, and bids fair to solve the problem of permanent protection at all points in all materials.

The fascine mat is made with about the same dimensions as the larger woven mats, 300 feet by 1,000 feet. It is constructed in the following manner:

First, a large head of hard-wood poles, 3 feet in diameter, is formed on the ways normal to the bank. To this head is fastened, at intervals of 8 feet, a 5/16-inch wire cable, and a 1¼-inch wire strand. Fascines about 11 inches in diameter made of bundles of willows are then placed parallel to and against the head, being forced well up to it and held in place by a turn of the wire strand and a clamp on the under cable. When ten feet (in length of mat) of the fascines have been placed, a second hard-wood head is constructed, taking the place of a fascine, and clamped in the same manner. These two heads form the head of the mattress, to which the mooring and shackle lines are attached, as well as the cables and wire strand. After the head is formed, the fascines are made and clamped into position so tightly that no spaces are left: indeed, the work is so compact that it will gradually sink from accumulation of silt. Transverse cables are also used, strengthening the mat and connecting it at intervals with the bank. On the top of the mattress are placed longitudinal poles fastened every 5 feet to the fascines with No. 7 silicon bronze wire. After completion, the mattress is first ballasted, by loading it with rock carried in wheelbarrows until its flotation is nearly destroyed: then

CONSTRUCTING FASCINE MAT ON MATTRESS WAYS.

it is sunk in the usual manner, by floating barges over it and throwing rock on it, in large quantities, by hand.

In the later work the upper bank is graded to a slope of 4 to 1, and on it is placed a pavement of rock and spalls carefully laid, instead of the willow shore mat, which is destroyed by natural decay in about three years.

There is a marked difference in the kinds of revetment that have proved successful in the river above the mouth of Red river and below, due to the fact that, below, the slope and width are less and the average depth greater. No obstructive bars or crossings occur, the caving

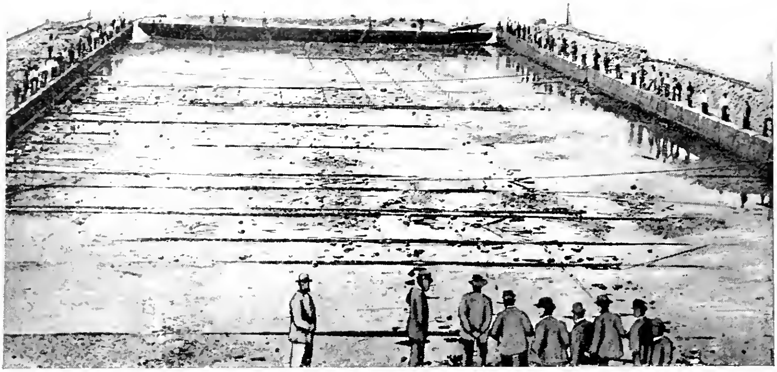
FASCINE MAT UNDER CONSTRUCTION.

is comparatively slight, and the range from high to low water at New Orleans is but one-third that at the mouth of the Arkansas. The velocity of the current at low water is very slight, and the radii of bends much greater as a rule. Interrupted revetment and dikes can be used in the lower river with much better results, and much weaker and lighter structures can be made effective.

It is in the vicinity of New Orleans that the first submerged crib dikes were placed as a protection to the city front. They were located at intervals of about 500 feet, being placed on foundation mat-

FASCINE MAT COMPLETED, READY FOR SINKING.

A PAVED BANK.



SINKING FASCINE MATTRESS; NEW ORLEANS.

tresses at first woven, afterwards of the pin and frame type. The foundation mattress was generally about 350 feet by 200 feet, with long axis normal to the bank, sunk between mooring barges with rock. The number of cribs composing the body of the dike varied with the depth of water and conformation of the subaqueous slopes.

The cribs were made of sawed timber frames, connected by long iron bolts and wooden posts fastened with wooden pins, between which and forming the body of the crib was placed willow brush, pockets being left in the construction in which to place the rock for sinking. The mattress required about seven pounds of rock for each square foot of surface, the cribs about seven pounds for each cubic

SYSTEM OF CABLES HOLDING MATTRESS DURING CONSTRUCTION.

foot of structure. The cost averaged about $7.60 per square foot for mattress, and 3¾ cents for crib per cu. foot. In the upper river, the crib work is carried to the top of the bank by framed structures similar to the submerged portion; in the lower river, by an earthen levee paved with rock.

Chief among the difficulties to be contended with in the work are the drift and snags. As the bank caves in the wooded reaches, it carries into the water large trees that for a long time remain upright in the river, forming snags over which it is impossible to sink mattresses. These are removed by powerful snag boats and explosives manipulated by divers.

A DRIFT-PILE ABOVE THE MOORING BARGES.

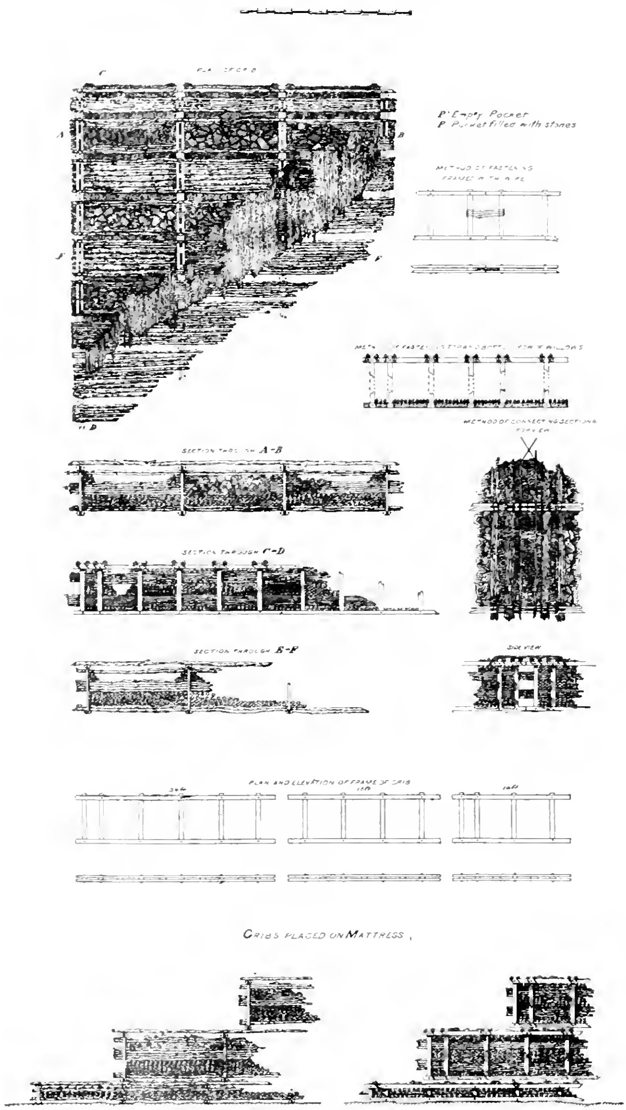
When a partially-constructed mattress, say 300 feet wide and 800 feet long, is in the water at the time of a rapid rise, much drift will accumulate at the upper side of the mooring barges, necessitating the use of great numbers of mooring cables. Sometimes the pressure becomes so excessive that it is impossible to contend with it, and the mattress is torn from its moorings. The pressure in a current 8 feet per second against a mat head extending 300 feet out into the river with drift lodged under it to a depth of fifteen feet is very difficult to counteract.

In the foregoing description of bank protection two distinctive

CRIBS.

SUBMERGED SPUR DIKES

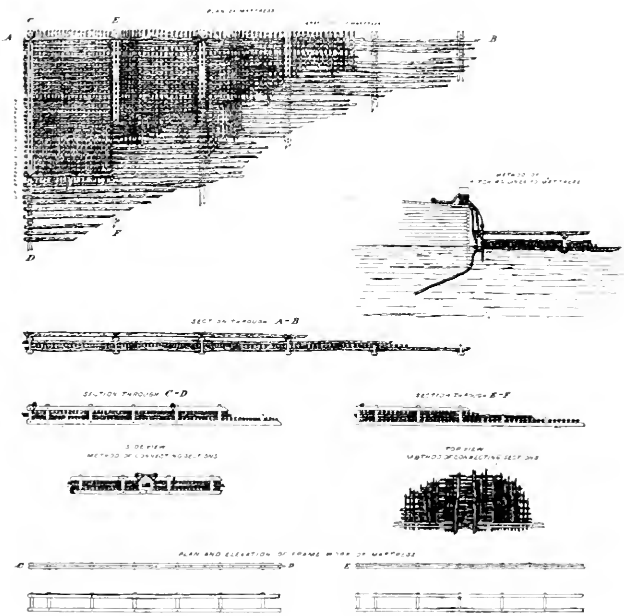
Scale of Feet.

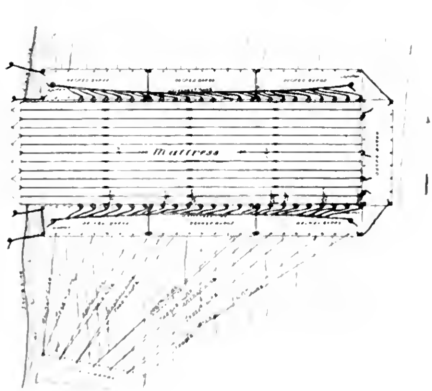


MATTRESS

SUBMERGED SPUR DIKES

Scale of Feet





PLAN

SPUR CONSTRUCTION; GREENVILLE, MISSISSIPPI.

types of construction have been noted,—continuous revetment and submerged spurs. The former offers little resistance to the flow of the water, but the latter cause reverse flow and the checking of the current, thus producing a deposit in the unprotected intervals, when effectual. In bends of great radius, light currents, and strong bank material, the spurs have proved very beneficial and permanent, placed at intervals of about 500 feet; but in abrupt bends in light soils, even at reduced distances, they are unsatisfactory. Unlike the continuous revetment, they obstruct the inshore channel, offering resistance to flow and changing the mechanical forces of the river from potentiality to active work which, if strong enough, means destruction of the structure or the bank beneath it. In some localities in the upper river they have been destroyed, or have sunk into pockets formed by the current, and the unprotected spaces have been attacked, necessitating the application of continuous revetment.

The following table gives the materials used and the cost of dikes and standard revetments, used at the present time below Cairo.

MATERIALS.

Kind of protection.	Brush cords.	Poles cords.	Stone cu. yds.	Wire lbs.	Cable lbs.	Spikes lbs.	Cost.‡
* Woven mat per lin. ft.	2.025	0.41	6.14	22.97	13.6		$29.07
† Fascine " " " "	4.48	0.17	7.76 Tons	11.50	36.04	3.7	30.04
Crib Dikes " cu. "	0.44	0.24	0.55	0.12	0.007		$3\frac{3}{4}$ c.

* Mat 250 ft. wide stone pavement.
† Mat 300 ft. wide stone pavement.
‡ Cost includes labor.

The early mats cost per square......	$12.00	approximately.
The standard-woven mats per square	4.50	"
The frame mats, New Orleans, per square........	9.00	"
The fascine mats, " " per square....	6.00	"
Brush shore revetment, New Orleans, per square...........	6.00	"
Pavement, per square..................................	10.00	"
Crib work of dikes per cu. ft..........	.04	"
Grading with hydraulic grader per cu. ft....................	.04	"

To build and sink a fascine mattress 300 feet wide requires from 250 to 300 men, and the average progress per day is about 150 lineal feet. Of the finished cost, about forty-five per cent. represents labor and fifty-five per cent. material.

The results obtained by bank revetment vary so in different localities, under different conditions, that it is difficult to give an intelligent idea of what has been accomplished as a whole. The early work has been to a great extent experimental, and in some localities valueless. Most of the heavy work, put in after the operations passed the experimental stage, still remains; and it is the author's opinion that, with the later forms described, a total expenditure of less than $30 per lineal foot will secure a protected bank which will withstand the wear and tear of the current and reduce the bar accretions, thus increasing the depth on the crossing and effecting an improvement in the low-water navigation.

A thorough and continuous revetment of the bank of the Mississippi, accompanied at first by the work of powerful dredges on the bars at low water, and the perfection of the levee system, will give uninterrupted and deep-water navigation.

MINOR MINERALS OF THE UNITED STATES.

II.

By David T. Day.

IN the preceding article, aluminum, mica, platinum and precious stones were discussed as native mineral products of differing interest and economic importance.

Asbestos. This substance is eagerly sought in this country and has been found in hundreds of places in the Appalachian rocks from Vermont to Georgia and in many western localities, but not a single well-established mine is in operation to-day. The main reason for this is the great supply of crysotile in Thetford and Coleraine townships, Quebec. This mineral is always referred to as asbestos, but is really a fibrous serpentine. Any mineral with a silky fiber is apt to be called asbestos; in fact, the writer has just received a sample of pure silica which was supposed to be asbestos because, under the microscope, it shows a fibrous structure which it probably acquired from the matted plant roots in which it was found.

Crysotile surpasses asbestos proper for all practical purposes. It is incomparably tougher, and admits of spinning and weaving to an extent which would be out of the question with real asbestos,—the latter being a fibrous variety of hornblende which is easily distinguished by being anhydrous, while crysotile has from ten to fifteen per cent. of water. Unfortunately most of the asbestos thus far found in the United States is real hornblende asbestos. Its fiber has proved brittle, though good enough for pipe coverings and similar things, where great strength and toughness of fiber are not essential. For these minor uses several deposits afforded a small product for years. Most interesting among these was a pocket of very good material (compared with the long Italian fibers, or, indeed, with any Canadian), found on Long Island, not far from Brooklyn. The pocket was exhausted and soon abandoned. The best promise of good supplies comes from the finds at Sal Mountain, Georgia, and another find in Wyoming, which is more like the Canadian than anything else yet found. The serpentines in western North Carolina should be carefully studied, as well as the similar rocks of California and Oregon.

Manganese and Chrome Iron Ore. For the higher grades of these substances there is a demand greater than the supply. These materials have in common the habit of occurring in pockets of greater or less size, but with an exasperating lack of persistence. The somewhat prevalent idea that we have very large supplies of manganese in connection with the Lake Superior iron ores and in well-known beds in the neighborhood of Batesville, Arkansas, and in Virginia, must be modified by the fact that custom has limited the demand to ores which are tolerably rich; that is, the percentage of metallic manganese must be about forty-four per cent. For many purposes this rules out the Lake Superior supply and much of the material from Arkansas. Virginia has supported the manganese industry for many years, and considerable supplies have also been furnished from Cartersville, Georgia, but the richer pockets have been exhausted as fast as they were found, although the great Crimora mine was a pocket of so unusual size as to furnish more than half of the total product of the United States for several years. Our lack of rich manganese ores would have compelled us to lower our standard and use the poorer ores, and even the manganiferous iron ores which are abundant in Virginia and in other parts of the country, except for the fact that Spain and, more recently, Cuba have come forward with high-grade supplies, which can be imported more economically than we can use lower-grade domestic ores.

Our manganese mining industry began with the foreign trade to supply the chemical industry of Great Britain. The very richest pyrolusite of Virginia was shipped in barrels to Liverpool for use in the manufacture of chlorine, but this trade was later injured by two conditions: first, the Weldon process for the recovery of the manganese, so that it could be used over and over again; second, the discovery in Nova Scotia of pyrolusite, which could be shipped in pure condition without any considerable purification, and which now controls the chemical trade.

Since the disturbing influence of the civil war many efforts have been made to regain this trade by producing a still purer material by very careful concentration of Virginia pyrolusite. The most interesting of these was the well-directed effort of Mr. Miller in Baltimore, who, working on a comparatively finely divided pyrolusite occurring mixed with clay in a large and unusually persistent deposit on the James river, was able to present to the European market pyrolusite of unequaled purity. But on the death of Mr. Miller the project was abandoned.

Practically all of our manganese now goes into the manufacture of spiegeleisen and ferro-manganese for the bessemer steel trade, and, with the western extension of this industry, the manganiferous iron ore of the Lake Superior region will no doubt be used more and more.

Manganiferous iron ores associated with the silver-lead ores of Leadville have also come into use, and will increase in importance with western development. Another source of manganese, which adds with considerable steadiness to the supply, is the residue from the manganiferous zinc ores in New Jersey, which will always constitute a well-developed factor in the supply. The total output, which in 1894 had fallen to 6308 long tons, rose in 1895 to 9547 tons valued at $71,769, the increase being due to developments in Georgia and some old producing states.

The chrome iron ore industry, like that of manganese, began in the United States with the production of an article for export to England, Scotland, and elsewhere; but it soon built up the manufacture of potassium bichromate in Baltimore, so that the factory there monopolized for many years the production of that substance in the United States. The efforts to compete with this enterprise may be counted not only by tens, but hundreds; only one, however,—the Kalion Chemical Company, in Philadelphia,—has succeeded. Foreign chrome iron ore makes the bulk of the raw material for both of these works, because the rich deposits in Maryland and Pennsylvania, which long served as the source of supply, have been worked out, with the exception of small reserves of unknown quality. Production then developed in northern California, and very many deposits of all sizes have been developed along the Coast Range from Del Norte county to San Luis Obispo. There was great demand for this material so long as the percentage of chromic oxid was above fifty, but the rich deposits were comparatively soon exhausted. Opportunely others were developed in Turkey by the investigations of Prof. J. Lawrence Smith. These ores continue rich in quality, and are transported at low freight rates. As the great cost of the process is in the decomposition of the ore, it pays to decompose only the richest that can be obtained, especially as these are more easily treated than the poorer ones, and yield, of course, higher results. Meanwhile, the keenest search is kept up for new deposits in this country, with fair prospect of success when more shall be known of the serpentine areas in the southwestern part of North Carolina and the adjoining region in Georgia. In fact, any large bed of serpentine may well be explored for chrome iron ore. The most promising of recent developments is the deposit recently explored in Coleraine township, Quebec. Possibly the lower grades of chrome iron ore will be resorted to, if the use of chromium in the manufacture of steel increases. The California production in 1895 amounted to 1740 long tons.

Sulphur. This, too, is a mineral which has been mined in the United States in a small way, and for which there is a great market whenever a convenient source of supply is developed. The supplies thus far found have been located in inaccessible regions of the west,—

in southern Utah and Arizona, and, in small deposits, in California; even in San Francisco, it is cheaper to import sulphur from Sicily or Japan. Lately, however, another deposit has excited much interest, although it is extremely inaccessible by reason of a bed of quicksand which covers it. This is at Sulphur City in south-western Louisiana. The ingenious process of Mr. Frasch, by which the sulphur is to be melted by hot water under ground and pumped to the surface, is being watched with great interest. The sulphur produced by this process must be cheaper than that which we import, and, while there is a great demand for sulphur in the United States, which is well supplied from Sicily, the possible success of this pumping method means a terrible loss to the Sicilian sulphur miners, who are none too prosperous with sulphur at its present prices. Their condition has not been improved by the Chance process for the recovery of sulphur from the Leblanc soda process. 1800 short tons of sulphur were produced in the United States in 1895.

The other chemical minerals—salt, phosphate rock, limestone for chemical purposes, borax, gypsum, pyrite, barite, and fluorspar—form a class of which the supply could at any time be increased.

Rock Salt. The distribution of large and easily-mined deposits of rock salt and salt brines is so plentiful that the process of selection has already partly excluded many of the poorer ones from the market, including the oldest member of the salt producers, Syracuse. This salt has already suffered in the decline, having been replaced by the saturated brines obtained from the rock-salt deposits at Warsaw and by the strong Michigan brines. In addition to these vigorous competitors, the rock-salt beds of Kansas are actively competing as a western supply, and in Cleveland a plant of particular efficiency is obtaining saturated brine from a deposit of rock salt underneath that city. In the meantime the rock-salt deposits of Petit Anse, Louisiana, have been reinforced by the discovery of a very thick deposit of rock salt on Orange Island. Besides this, we know of very extensive stores of rock salt for the future in south-eastern Arizona, in addition to the store in Salt lake itself. The Pacific coast is also independent of eastern supplies through the evaporation of the salt brines from the Pacific and the rock salt of the southern part of the State. It is strange that no more active search has been made among these rock-salt deposits for the discovery of deposits of potassium salts,—an industry which the United States lacks altogether, and which is limited practically to the potash beds near Stassfurt, Germany. We know so little concerning the salt deposits of the United States as to make it very possible that borings to the bottom of the larger of these may easily reveal beds of potash salts of equal importance with those in Germany; so far absolutely no such bed has been found in this country, but search is now beginning.

Nearly all the salt produced, with few exceptions, is almost pure. Still, a claim for existence has been made, with success, for two brands of salt on account of their exceptional purity. There are few commercial substances which are as pure as commercial salt; nevertheless, small traces of calcium chlorid and magnesium chlorid and sulphate make a vast difference as to whether the table salt will cake or not, and salt as nearly chemically pure as it will ever be profitable to make has lately been placed on the market. It is so free from calcium chlorid as to give only the slightest cloudiness to a solution of ammonium oxalate. The undoubted effect of all this will be to raise the grade of all dairy salt.

Phosphate Rock. This is a conspicuous example of a drug on the market, though in this case, in contrast with salt, the question of quality enters largely. There is still sale at remunerative prices for the highest grade of phosphate rock, such as the hard white phosphate produced in Florida, of which the quantity is undoubtedly limited as compared with that of other grades. While the Florida and South Carolina phosphates were struggling for supremacy, a third disturbing element was introduced,—the black phosphate rock of Tennessee, which, since its introduction, has, in spite of unfavorable location as regards freights, been received very favorably on account of the ease with which it yields to chemical treatment; it undoubtedly is in the market to stay. This phosphate rock is one of the surprises of the last few years, since it occurs in the Devonian system, whereas the phosphate rock which has heretofore supplied the United States is from very much younger formations. It occurs in a belt from two to eight feet thick, which comprises all there is of the Devonian in that region. This has led to a suggestion from Dr. C. Willard Hayes, of the United States Geological Survey, that it will be well to look for phosphate rock in other localities where, as in Arkansas, the Devonian formation exists in a very thin strip, corresponding to the thicker Devonian black shale of east Tennessee and Kentucky.

Another surprise was the discovery of phosphate rock a few months since in the Tuscarora valley of Juniata county, Pennsylvania, where, in the neighborhood of Reed's Gap, phosphates undoubtedly exist; it remains for the exploratory work of this spring to determine their value. This is sufficient to indicate that we know practically nothing of the geological conditions under which phosphate rock may be found in the United States, and leaves it an entirely open question how many large fields remain to be found, particularly in the less known regions of Arkansas, Indian Territory, and Texas.

Borax. This is the only soluble salt characteristic of the arid regions that is found commercially developed in the United States. It is true that, in addition, there have been frequent commercial ventures in the production of sulphate and carbonate of soda, and even attempts at producing potassium nitrate and sodium nitrate where indications of these substances have been found in the extreme south-west. But the conditions require exceptional diligence and perseverance for the survival of any of these industries, and borax alone has succeeded. The many illustrated articles which have appeared in current literature indicate the difficulty of first refining this material from the borax marshes of western Nevada and eastern California, and then making the long haul across the Mohave desert to railroad transportation. The industry has also had to battle with very active foreign competition, intensified by new discoveries in Tuscany and other European developments, and with unfavorable tariff legislation. Nevertheless, it succeeds. We can count upon ten million pounds of borax from this country with moderate certainty. In 1895 the production was 11,918,000 lbs., worth $595,900.

Gypsum and Barite. These are substances of which supplies beyond the normal demand have been discovered, and which depend for their existence, especially in the case of barite, on uses so questionable as to make the industry's condition precarious, although the results which have been obtained with barite in place of white lead, where the latter is not useful as paint, give this substance a permanent good standing in public opinion for special uses. In both of these industries the trade is again divided between domestic and foreign supplies, but with a continually better hold on the market for the domestic articles as the producers grow in strength.

Fluorspar. The production of fluorspar in the United States, amounting to 4000 tons in 1895, has been limited by the lack of a market, in spite of the advantage of its use in foundries as a desirable flux in remelting iron. Its use, however, in the production of hydrofluoric acid increases continually, although it is difficult to ascertain, or even imagine, what becomes of the considerable quantity of hydrofluoric acid daily produced. It is not accounted for by the increasing sales for etching glass-ware, or in any other way.

Fuller's Earth. The most remarkable evidence of the ability of the United States to respond quickly to an extended demand has been the adaptation of the clay, "Fuller's earth," in the place of animal charcoal, as a filtering medium for oils and other substances. No sooner did the demand for the imported article (which has been used in this country for years for the ordinary purposes of Fuller's earth) increase to any extent than large deposits were immediately discovered and put into service in this country. The main source of supply thus far has been Gadsden county, Florida, in the neighborhood of Quincy. Two companies are already engaged in the active production of this clay, notwithstanding the fact that it has been in use hardly more than a year. Their output was 6900 tons in 1895. It is a case of replacement of one substance by another, so that refiners, in practically discarding animal charcoal, have decreased its market value fully a third within a year. Further deposits of this material are known in southern Georgia as a northern extension of the deposits in Gadsden county, and indications of its presence are already sufficient to make it probable that comparatively enormous quantities will soon be produced, keeping this substance in the class of minerals of which there is a large over-supply.

Bromine. This is an interesting product which may at a moment's notice change from a condition of over-supply to one of great demand, on account of the experimentation now in progress to test its value as a disinfectant and also as a partial substitute for chlorine in the extraction of refractory gold ores. In the latter direction it is in connection with chlorine, rather than as a substitute for it, that it will probably go into use, and a number of recent patents in Germany and England for the quick and economical recovery of the bromine used make it probable that an enormous use for the substance will be found in this direction. Meanwhile, its adaptability for disinfecting purposes has been well proved by the Jacksonville epidemic of yellow fever. Fortunately, however, the demand in this direction is limited by the lack of epidemics, and, while very much disinfecting could be carried on to advantage at all times, it can not reasonably be expected that such will be the case until, through fear, the public is forced to it.

Nickel. The curious condition of the nickel industry is worth dwelling upon for a moment. It belongs in this same category of over-supply, where it was put by the development of the nickel mines of Sudbury, Canada. We produced, in 1895, 10,302 lbs. worth $3091, and in spite of the simultaneous increase in the use of nickel due to the preparation of nickel-steel, the quantity has kept well in advance of the demand, with the result that nickel has decreased about half in price in the last two years, without corresponding increase in its use for the old purpose of nickel-plating, etc. Undoubtedly much more steel will contain nickel in the future than in the past, and it would not require any great extensions in this direction so to increase the demand for nickel as to restore the old price, for in the steel industry the price of the nickel has little to do with the amount used; it is purely a matter of benefit to the steel, although, after this benefit is thoroughly established, it will be some time before the iron masters will generally adopt it.

Cobalt. The supply of cobalt in the United States, (14,458 lbs. in 1895) follows the nickel product. It is typical of a mineral which depends for its development upon that of a more important neighbor, —in this case, nickel. At present the production of both nickel and cobalt is a minor feature in the more important lead industry, there being an accidental occurrence of nickel and cobalt in small quantities in connection with certain lead ores in Missouri, from which it can, fortunately, be taken out in the form of a spiess; otherwise, both the nickel and cobalt industries are dead in this country. Great search has been made for nickel ores in the serpentine rocks of the Appalachian system. In Nevada, near Lovelock's station, deposits of cobalt and nickel arsenid have been found, and in Oregon nickel silicate similar to the garnierite of New Caledonia. But, after the more or less careless methods of exploitation, we are not yet in a position to state whether the deposits are workable or not. Very recent is the discovery of metallic pebbles of nickel and iron, which were at first supposed to be meteorites, in placer ground in Josephine county, Oregon. From the county they have taken the name of josephinite. To discover the source of these pebbles and of a supply of nickel has been the object of much prospecting, but with no result.

Corundum and Emery. These substances are typical of a class of minor minerals in which the trade is dominated by foreign supply and in which the domestic product has been continually obliged to struggle against a well-established import trade, although the native mineral far outranks the foreign in quality. The production of emery in the island of Naxos is very ancient, and the importation of material from Greece received a new impetus by the discoveries of magnesite, chrome iron ore, and emery by Prof. J. Lawrence Smith in the neighborhood of Smyrna and Ghimlek. The essential conditions which make it possible for these Smyrna deposits to practically dominate in the supply are, first, that all three of these articles are found together, and, second, that the conditions of occurrence are such as to admit of easy mining. The labor, which is very cheap, suffices for the industry there, though it might not elsewhere. Nevertheless, this foreign emery, which has only from forty to fifty per cent. of the hardness of the best material found in this country, must eventually give way as recognition is obtained for the superior quality of the products which we can obtain at home. The condition is a complicated one on account of the steps necessary in exploiting the deposits of ore: selecting the best of the materials and carefully separating them from softer accompanying minerals; then turning the whole product over to another line of business, which has been the sizing and sale of emery sand; and then to a third set,—wheel-makers. This is too long a series of processes for the final user of the wheels to grasp, and he has relied simply upon the cheapest wheels which would give efficient results. The average user is entirely unacquainted with any exact standard of merit for the wheels, and is not capable of appreciating the distinctions which must be made when easy and accurate methods of estimating the abrasive capacity of corundum and emery come into common use. As it is, in addition to the emery plentifully found at Chester, Massachusetts, and in Westchester county, New York, and the corundum of Chester county, Pennsylvania, and of similar serpentine belts already mentioned (which run with great persistence for one hundred and fifty miles or more parallel with the Blue Ridge and about ten miles from the summit on the north-west side), corundum of all varieties of hardness can be obtained, from nearly pure sapphire to corundum of inferior quality. The direction given to prospecting by the fact that this corundum usually occurs on the line of contact between these large dikes of serpentine and the inclosing hornblende gneiss will certainly lead to the development of many more deposits in North Carolina and Georgia, and the development of a greater corundum and emery business in this country, at the sacrifice of the imports from abroad; which is fortunate, since, of the three materials,—corundum, native emery, and imported emery,—the imported emery is certainly the least efficient. The question between the value of corundum and emery is all the more an open one from the fact that the best result is largely due to the best wheel-makers; in other words, the process of making the wheels themselves can be carried out with such skill as to produce a better wheel from poorer raw material than is often made from the very best corundum.

In addition to the foregoing minerals, deposits of many others are known to exist in this country,—even of minerals which find useful applications in other lands, but for which a market has not yet developed in America; and there are others again which are matters of daily produce, but are thrown away for lack of interest in saving them or of a market when they are saved. One has but to think of the enormous aggregate quantity of such substances as arsenious oxid and others, particularly such rare minerals as bismuth and cadmium, which are continually being thrown off into the air from waste gases in western smelting works.

Among the minerals for which there is practically no market may be mentioned zircon, rutile, uraninite, gummite, ilmenite, fergusonite, samarskite, columbite, and gadolinite; and, within a few years, monazite might have been included in the number. This furnishes a convenient example of how considerable deposits of what was an extremely rare mineral can readily be obtained, if a demand for it is fairly well advertised. Although this mineral has been known to occur in many places in granitic rocks, and has been noticed in more than a dozen localities in the United States, besides the present sources of supply in North Carolina and South Carolina, as well as in Canada, South America, England, Sweden, Norway, Russia, Belgium, France, Switzerland, Germany, Austria, and Australia, it was one of the very rare mineral curiosities when that enterprising economic mineralogist, Prof. W. E. Hidden, observed its occurrence in considerable quantities in Burke and McDowell counties, North Carolina, in 1879. As soon as an economic value was established for it on account of the incandescent properties of the oxids of cerium, didymium, and thorium, which it contains, it became a commercial article. It is the thoria for which it is principally valuable in the manufacture of the Welsbach and other incandescent gas lights. The cerium is also utilized, going into the drug trade in the form of the oxalate. The industry is a rather uncertain one, on account of the variation in the amount of thoria which the monazite contains. Thoria is there rather as an impurity than as an essential constituent, the monazite being principally phosphate of cerium, the thoria usually constituting only from three to seven per cent. of the total weight. It is curious also to notice how a number of geologists now bring forward the idea that monazite can be found in any granitic rock; in fact, that its presence is a fairly good test as to whether a rock is granitic or not.

Finally, there is an interesting list of useful minerals which are not now mined in this country, although deposits of all of them have been described. Among them are alabaster, celestite and strontianite, pumice, chalk, alunogen, mineral soap, ozocerite, lithographic stone, hanksite and other soda minerals, ulexite, tincal, obsidian, wolfram, vanadinite, and greenockite.

Frequent projects have been evolved for using one or another of these, and abandoned usually not because of lack of supply, but from inaccessibility; for it may be noticed that most of these are found in the unopened west, and cheaper supplies can be imported. In such cases the failure to use them, and the preservation of a supply for the future, cannot well be regretted.

QUACKERY IN ENGINEERING EDUCATION.

I.—A CRITIC'S CONFUSION OF ENGINEERS WITH ARTISANS.

By Edward H. Williams, Jr.

MR. KIDWELL appears in your May number, brimful of wrath, and, after mauling the life out of the course at Cornell, because it pretends to teach practical use of tools in the limited time that can be given to such things,—wherein he is eminently correct,—he does not stop in the safe place he has made for himself; but, wheeling diametrically about, he "sails into" the Lehigh course, because it does not contain practical work. He is not right in both cases.

Granted that life is short, and that it is of first importance that a course should end in time to allow a man to do a little practising before he dies, and granted, further, that the length of the course must be limited by the money a man can invest in it, it is required to plan an "engineering" course,—not a course for an artisan. To be an engineer one must have a thorough working knowledge of the higher mathematics. Unless the entrance requirements are at the top notch, this means that parts of two years will be necessary for its perfect acquisition. Then come the applied mathematics, experimental physics, mechanics, strength of materials, some knowledge of chemistry, and a facility in handling drawing-instruments that can come only from time, and an accuracy in their use to be obtained only from experience. Is the man to be a mechanical engineer? He must have a a thorough knowledge of thermodynamics, kinematics, fuels, iron metallurgy, and measurement of power. He possibly can get along without a knowledge of the modern languages; but he must rely then on translations, and, unfortunately, the best text-books in the science are in German and French,—preferably the former. To read these he must put in the continuous work of parts of three years, as technical German is no joke. In the time that is left he must learn all that he can about machinery,—not machines; Mr. Kidwell does not seem to know the difference between the terms,—and here is where the ways diverge. If he is to know about machinery, he goes in one direction; if about machines, he will never become an engineer, but he may know all about chipping, filing, etc. Let me now tremblingly, a missionary to the heathen, and with, perhaps, a similar fate before me, preach my brief preachment.

Let me start with the axiom that the engineer works with his head, while the artisan uses his hands. The former knows by careful study of work, as well as by comparison of good, indifferent, slovenly, and bad work, how work should be performed; what conditions govern its inception; what economic questions must be settled before its undertaking: the latter knows how to do certain kinds of work well on certain tools, and by experience becomes a "skilled workman"—and nothing more. The one looks beyond the work to the tools; their arrangement; the building in which they are housed; the motors which run them; the economy of the service, and the ultimate profit: the other moves in his little circle, knows his little stint well—and nothing more. The "engineering" school teaches the student humility, as it opens to his vision the wonderful works of the past, and shows him how small and insignificant he is in this great world, which is so old and so critical. The "shop" teaches the man the shop traditions, lets him see all that the walls contain. The man soon "knows it all"; becomes cocky and self-opinionated; comes down from his little draughting-room, in the shop of the logging road he serves, to "inspect" the work the Baldwin people, for instance, are doing for them. He cuts a wide swath for a day or two; gets all the rope needful, and hangs himself. During the rest of his life he boots himself all over that shop because he did not know enough to keep his mouth shut. The "engineering" school teaches the student that each instance brought to his attention is simply an instance; that each novel instance must be solved by comparison; that the future has myriads of such instances, no two alike, and that only by abundant practice in their solution can he hope to become expert; that he must begin at the bottom of the stair with a low salary; that he can learn something from the navvy on the spoil-bank and the wiper in the stalls. It does not waste time in giving a man a smattering of how to file square; to swing a pick; to tighten bolts on a bridge, or pound his mate's hands in an effort to hit the drill-head. The truly egotistical man is the self-made man who has worked in his little circle till the grass is worn off; the man who thinks he has invented what the nearest library would show to have been common property since the creation. This man wishes the embryo engineer to fritter away his time in learning how to perform manual labor which he will under no circumstances put in practice in after-life; which will seriously cut into the time allotted to his education; which, as Mr. Kidwell shows, can be at best but superficial and valueless; and which will make him as narrow and self-opinionated as the man of straw set up by Mr. Kidwell for chastisement.

I should much like to have Mr. Kidwell come to Bethlehem and see the results of a course approved by one whom the American Mechanical Engineers have chosen to guide their meetings, and for which such engineers as John Fritz and the late Eckley B. Coxe stood sponsors, as trustees of the institution which offers it. Perhaps he might get a knowledge of the difference between machines and machinery, as he queries at the latter word in his sneer at the course. Perhaps, after a course of sprouts during two years in the immense works of the Bethlehem Iron Company, of daily afternoon occurrence, and weekly comparisons at Easton in the L. V. R. R. repair shops,—perhaps, I say, he might learn how a plant could be used to its highest advantage. Meanwhile I will ask him to study the article in your magazine which showed that Lehigh mechanical engineers were not afraid of low salaries, and obtained positions more readily than those with whom they were compared. Here, certainly, there is not cockiness, or a desire to "boss the ranch" at the start.

Let me further preach that the professor in charge of a course knows better the needs of the course than either the artisan or the expert. The first is constantly asked for men to do certain things; is told of new departures; is freely consulted, because his position makes him the father-confessor, from whom all think they can get advice *gratis*. What the artisan sees over the sideboards of his treadmill is not the world. The expert, to be truly one, must specialize, and thus leave broad for narrow grounds. He may be lord-paramount in his little sphere; but he must stay therein, if he is to dogmatize. It is always an unfortunate day for him, when he flops laboriously to the top of the fence and crows defiance to the world, as it shows him that security of position is nearer the ground. In the future let the critic and comparer lay down the rule followed by every engineer: study the results before going ahead. It is far easier to criticise and destroy than to build.

Mr. Kidwell is sound, however, when he attacks Mr. Thurston's estimate of an endowment. The desire of Johns Hopkins that his money should be invested in brains rather than bricks and mortar should be pasted in the hat of each educator. The right man will find the illustrations. The chemical work which laid the foundations of chemistry and discovered the elements was developed in a kitchen-sink with the stems of tobacco-pipes.

II. THE BROAD VALUE OF A TECHNICAL TRAINING.

By D. C. Jackson.

THERE can be no difference of opinion upon the importance to engineering students of a taste for the study of applied mathematics and applied mechanics as well as a readiness with eye, ear, and hand; but, above all, success upon the part of such students is dependent upon a love of hard, consecutive work. The fact that many students who have not the gifts required in the engineer's profession have been attracted to the engineering schools and have continued in ill-adapted courses to graduation has led to much pessimism in regard to the supply of, and demand for, young engineers. The engineering schools, however, have never yet caused an over-supply of sensible, hard-headed young men with a first-class training of their faculties,—young men having a useful knowledge of applied mechanics at their fingers' ends,—and they never can cause an over-supply of such young men until the country has reached stagnation and ruin. The welfare of the country is indissolubly bound up with the continuance of the industrial life which has been brought about by engineering knowledge and invention.

Of all the immense wealth held by the individuals of this country, the enormous proportion of between one-fourth and one-third is directly employed in operations dependent for success upon engineering knowledge and skill, and much additional public money is invested in improvements made possible through the skill of the engineer. This points conclusively to a great demand for well-trained, conscientious engineers, and the demand is proved by an examination of the employments of the graduates of the twenty or twenty-five first-class engineering schools of the country. It also points to the importance of a general dissemination of engineering knowledge. We seldom hear the claim that a legal training is wasted on a business man, and there is no ground for the claim that an engineering education is wasted on any man who has a responsible connection with industrial enterprises. Indeed, there is good ground for the claim that an engineering college course is one of the most satisfactory preparations for the life of the average man, since it tends to enliven his intellect and strengthen his resources where strength is most needed.

It is not to be expected that engineering students will obtain lucrative employment immediately upon graduation, or, indeed, that all will go directly into engineering occupations. The proposition that the engineering schools shall make finished engineers is absurd, and it is unreasonable to expect that graduates will be taken at once into the confidence of their employers, or be placed, immediately after graduation, in positions of responsibility. It is natural and proper to look with suspicion upon the capabilities of the medical graduate, however fine his college training, until he has spent considerable time and gained much experience in hospital service or in practice under the direction of an experienced physician. The legal graduate also serves an apprenticeship as a law clerk, before he is entrusted with important duties. In the same way the engineering graduate must prove his worth in a subordinate place, before he is entrusted with responsibility or with confidential affairs. Forgetfulness of this universal fact leads to many heartburnings and much pessimism on the part of new graduates, some of which finds its way into articles in the technical journals. Nor can we judge of the usefulness or success of engineering schools by canvassing the positions held by the members of the last class graduated. If all graduates of a few months' standing were found to be in places of more or less responsibility, it would be fair proof that their instruction in the engineering schools had been devoted too exclusively to a superficial instruction in "engineering practice" rather than to a properly-balanced proportion of principles and practice. The former doubtless gives the graduate the better chance to "get a good position" at once, but it leaves him with a lamentably weak foundation upon which to improve the position. The true way to determine the usefulness of engineering schools is to examine the registers of their graduates during the past fifteen years (or, better, for twenty-five years past), and from them determine the proportion who have made marked improvements in the industries, have materially advanced the welfare of the land, or have won distinction in their life. A parallel examination made upon this basis of the graduate registers of the colleges of engineering, medicine, and law, and of the so-called humanistic courses, shows results greatly to the credit of the engineering schools, and conclusively proves that engineering education is not overdone. Such an examination points so clearly, indeed, to the ample advantage gained by the country from the engineering schools as to suggest the advisability of bringing those of higher grade into closer relations to the national life, without, however, in any way weakening their local connections, which are often of the greatest utility.

III. DISAGREEMENT OF THE DOCTORS OVER THE MINING COURSE.

By H. K. Landis.

Apparently, the educational and patent-medicine ponds are equally open to quacks who thrive and paddle about in peace in the undisturbed waters until a Munroe or a Kidwell calls for a reckoning; in both "the doctors disagree," not because there is any difference in the end to be accomplished, but rather because the "doctors" find it difficult to diagnose the case, and submit as a remedy some high-sounding "cure for all diseases." As Mr. Edgar Kidwell, in the May number of this magazine, shows that such quackery exists in general, we will take the special case of mining schools. Jacob's coat could not have been more varied. One church school teaches the New Testament ; a university enlarges on the French revolution and the history of Europe ; a southern school finds agriculture and military science necessary ; while another utilizes its paid dominie to give instruction in Christian Evidences ; and all to teach a youth how to make iron and steel or manage a gold mine. It may be right to fill in the foundation of an education with stumps and other rubbish, because it is handy, but we can scarcely be asked to take it for granted that it is good practice, because some Ph. D. claims that it is.

Let us look into this diversity further. From a list of 34 mining schools and courses we take the following instances, arranged according to the cause for variation in the departments of instruction, and scaled with reference to the relative time devoted to each department in a four years' course.

Dominant factors in certain schools.	Physical Science.	Chemistry.	Mathematics.	Mechanical Engineering.	Civil Engineering.	Mining Engineering.	Literary.	Miscellaneous.
Strong Chemical Dept	9	17	7	6	7	7	11	9
" C. E. "	6	3	7	7	15	3	4	2
" Mining "	5	10	5	10	5	15	4	2
" Literary "	7	11	6	3	12	4	20	5
Location near mines	4	8	4	8	6	10	..	..
A Southern college	6	7	4	7	4	5	14	2
An Australian school	4	14	6	6	4	11	..	..
A German school	3	18	5	16	11	30	5	..
Average of 34 mg. schools	4	10	7.5	7	7.5	9	5	2

There is not here a question as to which is the better, but rather a grave suspicion that some of our educators have not even the remotest idea what a professional mining engineer or metallurgist is required to know in order to follow his profession. Here are some of the subjects they require for the degree of mining engineer :

Military drill.	Elocution.	Constitutional law.
Shop wood-working	Art of war.	Photography.
Shop iron-working.	Greek.	Sanitary engineering.
Bookkeeping.	Logic.	Aerodynamics.
Civil government.	Irrigation.	Astronomy.

The list might be prolonged with compulsory chapel attendance, prizes for good conduct, etc., if space and patience permitted.

We find among the men who direct our mining schools ministers of the gospel, mathematicians, lawyers, civil engineers, scientists, and, in a few isolated cases, real mining men. The results are in accordance. It rarely happens that a good mining engineer or metallurgist of experience occupies a professor's chair for any great length of time, as the restrictions which force him into the same groove with the teacher of history or mathematics become exceedingly irksome. The chair, as well as the profession, should be in direct contact with the latest practice ; it will not answer to compile lectures from published literature, if the teaching is to be what the student needs ; the student must study as much as possible the method or process on the ground. It is humbug of the highest order to grade a man as a mining engineer when he never has seen the inside of a mine or felt the heat of a furnace ; and yet it is done repeatedly. Mr. Kidwell may be right in the example cited, but, if a professor of mining wants to be of value to his students, he must not only tell how a substance is mined but also what it costs to mine it, what it sells for, who buys it, how it is manufactured, the market value of the product, who consumes it, and into what article it finally goes ; and this requires an intimate knowledge of and contact with changing commercial conditions. Mr. A. M. Wellington, editor of the *Engineering News*, says, "The fundamental error in all our schools is in giving too much thought to *what* is studied and too little to *how* it is studied. Choctaw, Chaldee, Egyptian inscriptions, or anything else studied in such a way as to train the mind to think and be thorough, is good," and strongly recommends experimental work. The problem, and claim made by the schools, is to educate a man that he may meet all demands made on him by his profession. This does not imply thorough knowledge, but rather a sufficient groundwork, acquired information, general culture, and mental habits to enable him to rise successfully to any occasion in his profession ; and any scheme that introduces unnecessary factors in his training, or fails to do what it claims to do, is rank humbug. The end to be attained is the first thing to be considered. Mr. Eckley B. Coxe puts it : "Not knowing exactly what you want to do nor the material you have to do it with, what is the best way of doing it ?" This is the precise situation ; in a paper before the Am. Soc. of Mech. Eng. he says that a mining engineer may be "either a business engineer, constructing engineer, managing engineer, theoretical engineer, compiler, or teacher" but where is the school that directs its instruction according to any such classification ? A few of the smaller institutions turn out prospectors, assayers, draughtsmen, surveyors from short courses, but our best schools aim toward superintendents full of theory and laboratory work, which, according to Mr. H. O. Hofman, "tends to produce theorists, who speak with unwarranted assurance concerning the most difficult problems the engineer has to solve ; but who, if confronted with a simple, concrete question, are at loss what to do," and, we might add, tend to bring the profession into disrepute. To be successful, a man must know one thing well, have particular information on adjacent lines, and a broad knowledge of men. Aside from technology, he should be familiar with mine and works accounts, the laws relating to the transfer of property, customs regulating the handling of money, the proper forms and precautions to be observed in legal papers, the systems in use in the handling and organization of employees, and, above all, the ability to write and speak his own language with correctness and fluency. And yet our mining schools will toss "the poor graduate" from their front door among the bunco men, mining sharks, silver-tongued speculators, and shrewd business men, with the direction to swim or sink, and smile at the comedy while the young man is getting his experience. The humbug lies in their claiming to have taught him the things necessary to him in his profession.

IV. PRACTICAL SCHOOL METHODS AND IMPRACTICABLE DEMANDS.

By George L. Hoxie.

QUACKERY in engineering education, as elsewhere, is something much to be deplored, and, if it can be proved to exist, we should at once bestir ourselves to get rid of it.

It is difficult, however, to understand the object of such an article as appeared in the last issue of this magazine, unless it be to convince us that those institutions which we have come to regard as the leading ones in technical education are in reality mere shams, much inferior to many obscure colleges,—their large and costly equipment useless, and perhaps, indeed, positively detrimental. From such a view the writer wishes to emphatically dissent.

It is doubtless true that the first attempt of a young graduate "to bore out an eight-foot cylinder" would probably prove disastrous. No technical school trains its students to do such heavy work, or makes the slightest pretence of doing so. Yet in all well-managed institutions the average student does gain a surprising facility in the use of small tools and in ordinary shop-processes, and it is not "quackery" to say so. Certainly one may often find specimens of students' work comparing favorably with that turned out by "old hands."

It may be that no startling discoveries have been made with the "experimental steam engines representing from $10.000 to $15,000." The ordinary graduate is, or should be, well satisfied, if he has been thoroughly instructed in the latest advances made by men who have had a life-time of professional experience. It is not to be expected that he will begin to instruct the world before receiving his diploma. However, any candid man must admit that those schools which, through lack of funds or mistaken judgment, attempt to teach the theory and practice of compounding, jacketing, and all the many other details entering into the economy and management of modern large power units, "on an engine costing not more than $700," are at a serious disadvantage. Such instruction must savor of the note-book method of shop-practice, so strongly condemned by Mr. Kidwell.

Again, he tells us that a college is "guilty of educational quackery," when it permits its professors to engage in an outside engineering practice. From another part of the same article, one infers that the undertaking of "tests for money," and even the writing of books, and presumably of magazine article, are included in this general condemnation. It should be unnecessary to point out that able men are often secured by schools which cannot pay for the exclusive right to their services. So long as a professor renders a fair equivalent of labor for the salary received, no one is defrauded. It may well happen that such a man, by keeping in touch with practical matters, becomes better able to teach them. As to the undertaking of tests, it is surely an invaluable privilege for a manufacturing community to have at hand a laboratory in which tests of all kinds may be conducted with absolute fairness. Such testing should be considered a part of the legitimate work of every institution equipped for it.

While in some cases abuses may have resulted from allowing a private engineering practice, the writer chooses to believe that such instances as are related in the article referred to are at least uncommon. Certainly the attempt to restrict the activities of a professor as suggested cannot but be injurious in the extreme.

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American Gas Light Journal. *w.* $3. New York.
American Geologist. *m.* $3.50. Minneapolis.
American Journal of Science. *m.* $6. New Haven.
American Journal of Sociology. *b-m.* $2 Chicago.
American Machinist. *w.* $3. New York.
American Magazine of Civics. *m.* $3. New York.
Am. Manufacturer and Iron World. *w.* $4. Pittsburg.
American Miller. *m.* $2. Chicago.
American Shipbuilder. *w.* $2. New York.
Am. Soc. of Irrigation Engineers. *qr.* $4. Denver.
Am. Soc. of Mechanical Engineers. *m.* New York.
Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
Archæologist, The. *m.* $1. Columbus, O.
Architect, The. *w.* 26s. London.
Architectural Record. *q.* $1. New York.
Architectural Review. *s-q.* $5. Boston.
Architecture and Building. *w.* $6. New York.
Arena, The *m.*. $5. Boston.
Australian Mining Standard. *w.* 30s. Sydney.
Banker's Magazine. *m.* $5. New York.
Banker's Magazine. *m.* 18s. London.
Bankers Magazine of Australia. *m.* $3. Melbourne.
Board of Trade Journal. *m.* 6s. London.
Boston Journal of Commerce. *w.* $3. Boston.
Bradstreet's. *w.* $5. New York.
Brick. *m.* $1. Chicago.
Brick Builder, The *m.* $2.50. Boston.
British Architect, The. *w.* 23s. 8d. London.
Builder, The. *w.* 26s. London.
Bulletin Am. Geographical Soc. *q.* $5. New York.
Bulletin Am. Iron and Steel Asso. *w.* $4. Phila.
Bulletin of the Univ. of Wisconsin, Madison.
California Architect. *m.* $3. San Francisco.
Canadian Architect. *m.* $2. Toronto.
Canadian Electrical News. *m.* $1. Toronto.
Canadian Engineer. *m.* $1. Montreal.
Canadian Mining Review. *m.* $1.50. Ottawa.
Century Magazine. *m.* $4. New York.
Chautauquan, The *m.* $2. Meadville, Pa.
Clay Record. *s-m.* $1. Chicago.
Colliery Engineer. *m.* $2. Scranton, Pa.
Colliery Guardian. *w.* 27s. 6d. London.
Compressed Air. *m.* $1. New York.
Contemporary Review. *m.* $4.50. London.
Cosmopolitan, The *m.* $1.20. New York.
Domestic Engineering. *m.* $2. Chicago.
Electric Power. *m.* $2. New York.
Electric Railway Gazette. *w.* $3. New York.
Electrical Age. *w.* $3. New York.

Electrical Engineer. *w.* 19s. 6*d.* London.
Electrical Engineer. *w.* $3. New York
Electrical Engineering. *m.* $1. Chicago.
Electrical Industries. *m.* $1. Chicago.
Electrical Plant. *m.* 6s. London.
Electrical Review. *w.* 21s. 8*d.* London.
Electrical Review. *w.* $3. New York.
Electrical World. *w.* $3. New York.
Electrician. *w.* 24s. London.
Electricity. *w.* $2.50. New York.
Electricity. *w.* 7s. 6*d.* London.
Engineer, The. *s-m.* $2.50. New York.
Engineer, The. *w.* 36s. London.
Engineer & Contractor. *w.* $1. San Francisco.
Engineers' Gazette. *m.* 8s London.
Engineering. *w.* 36s. London.
Engineering and Mining Journal. *w.* $5. N. Y.
Engineering Magazine. *m.* $3. New York.
Engineering-Mechanics. *m.* $2. Phila.
Engineering News. *w.* $5. New York.
Engineering Record. *w.* $5. New York.
Engineering Review. *m.* 7s. London.
Eng. Soc. of the School of Prac. Sci. Toronto.
Eng. Soc. of Western Penn'a. *m.* $7. Pittsburg.
Fairplay. *w.* 32s. 6*d.* London.
Fire and Water. *w.* $3. New York.
Forester, The. *bi-m.* 50 cts. May's Landing, N.J
Fortnightly Review. *m.* $4.50. London.
Forum, The. *m.* $3. New York.
Foundry, The. *m.* $1. Detroit.
Garden and Forest. *w.* $4. New York.
Gas Engineers' Mag. *m.* 6s. 6*d.* Birmingham.
Gas World, The. *w.* 13s. London.
Geological Magazine, The. *m.* 18s. London.
Gunton's Magazine. *m.* $2. New York.
Heating and Ventilation. *m.* $1. New York.
Ill. Carpenter and Builder. *w.* 8s. 8*d.* London.
Improvement Bulletin. *w.* $5. Minneapolis.
India Rubber World. *m.* $3. New York.
Indian and Eastern Engineer. *w.* 20 Rs. Calcutta.
Indian Engineering. *w.* 18 Rs. Calcutta.
Industries and Iron. *w.* £1. London.
Inland Architect. *m.* $5. Chicago.
Inventive Age. *s-m.* $1. Washington.
Iron Age, The. *w.* $4.50. New York.
Iron and Coal Trade Review. *w.* 30s. 4*d.* London
Iron & Steel Trades' Journal. *w.* 25s. London
Iron Industries Gazette. *m.* $1.50. Buffalo.
Iron Trade Review. *w.* $3. Cleveland.
Journal Am. Chemical Soc. *m.* $5. Easton.
Jour. Am. Soc. Naval Engineers. *qr.* $5. Wash.
Journal Assoc. Eng. Society. *m.* $3. St. Louis.
Journal of Electricity, The *m.* $1. San Francisco.
Journal Franklin Institute. *m.* $5. Phila
Journal of Gas Lighting. *w.* London.
Jour. N. E Waterw. Assoc. *q.* $2. New London.
Journal Political Economy. *q.* $3. Chicago.
Journal Royal Inst. of Brit. Arch. *s-q.* 6s. London
Journal of the Society of Arts. *w.* London.
Journal of the Western Society of Engineers. *b-m.* $2. Chicago.
Locomotive Engineering. *m.* $2. New York.
Lord's Magazine. *m.* $1. Boston.
Machinery *m.* $1. New York.
Machinery. *m.* 9s. London.
Manufacturer and Builder. *m.* $1.50. New York.
Manufacturer's Record. *w.* $4. Baltimore.
Marine Engineer. *m.* 7s. 6*d.* London.
Master Steam Fitter. *m.* $1. Chicago.
McClure's Magazine. *m.* $1. New York.
Mechanical World. *w.* 8s. 8*d.* London.
Metal Worker. *w.* $2. New York.
Milling. *m.* $2. Chicago.
Mining. *m* $1. Spokane.
Mining and Sci. Press. *w.* $3. San Francisco.
Mining Industry and Review. *w.* $2. Denver
Mining Journal, The. *w.* £1. 8s. London.
Mining World, The. *w.* 21s. London.
National Builder. *m.* $3. Chicago.
Nature. *w.* $7. London.
New Science Review, The. *qr.* $2. New York.
Nineteenth Century. *m.* $4.50 London
North American Review. *m.* $5. New York.
Overland Monthly. *m.* $3. San Francisco.
Paving & Munic. Eng. *m.* $2. Indianapolis.
Physical Review, The. *b-m.* $3. New York.
Plumber and Decorator. *m.* 6s. 6*d.* London.
Popular Science Monthly. *m.* $5. New York.
Power. *m.* $1. New York.
Practical Engineer. *w.* 10s. London.
Proceedings Engineer's Club. *q.* $2. Phila.
Progressive Age. *s-m.* $3. New York.
Progress of the World, The. *m.* $1. N. Y.
Railroad Car Journal. *m.* $1. New York.
Railroad Gazette. *w.* $4.20. New York.
Railway Age. *w.* $4. Chicago.
Railway Master Mechanic *m.* $1. Chicago.
Railway Press, The. *m.* 7s. London.
Railway Review. *w.* $4. Chicago.
Railway World. *m.* 5s. London.
Review of Reviews. *m.* $2.50. New York.
Safety Valve. *m.* $1. New York.
Sanitarian. *m.* $4. Brooklyn.
Sanitary Plumber. *s-m.* $2. New York.
Sanitary Record. *m.* 10s. London.
School of Mines Quarterly. $2. New York.
Science. *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York.
Scientific Am. Supplement. *w.* $5. New York.
Scientific Machinist. *s-m.* $1.50. Cleveland, O.
Scientific Quarterly. *q.* $2. Golden, Col
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Journal of Eng. *m.* $2. Ithaca, N. Y.
Southern Architect. *m.* $2. Atlanta.
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago.
Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn.
Trans. Am. Ins. Electrical Eng. *m.* $5. N. Y.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* $10. New York.
Transport. *w.* £1. 5s. London.
Western Electrician. *w.* $3. Chicago.
Western Mining World. *w.* $4. Butte, Mon.
Western Railway Club, Pro. Chicago.
Yale Scientific Monthly The. *m.* $2.50 New Haven.

ARCHITECTURE & BUILDING

See also "Civil Engineering" and "Domestic Engineering."

Mr. Thomas Hastings.

THE extraordinary talents of Mr. Thomas Hastings form the theme of an article by Mr. Barr Ferree in *Stone* for March, in the series he is contributing to that magazine on "Notable Stone Buildings in New York." The Mail and Express Building serves as the text. This structure is remarkable in more than one way, for, while not pleasing as a whole to look at, it bears evident marks of being the work of a scholar and an artist, and is, in a way, one of the most notable buildings in the metropolis.

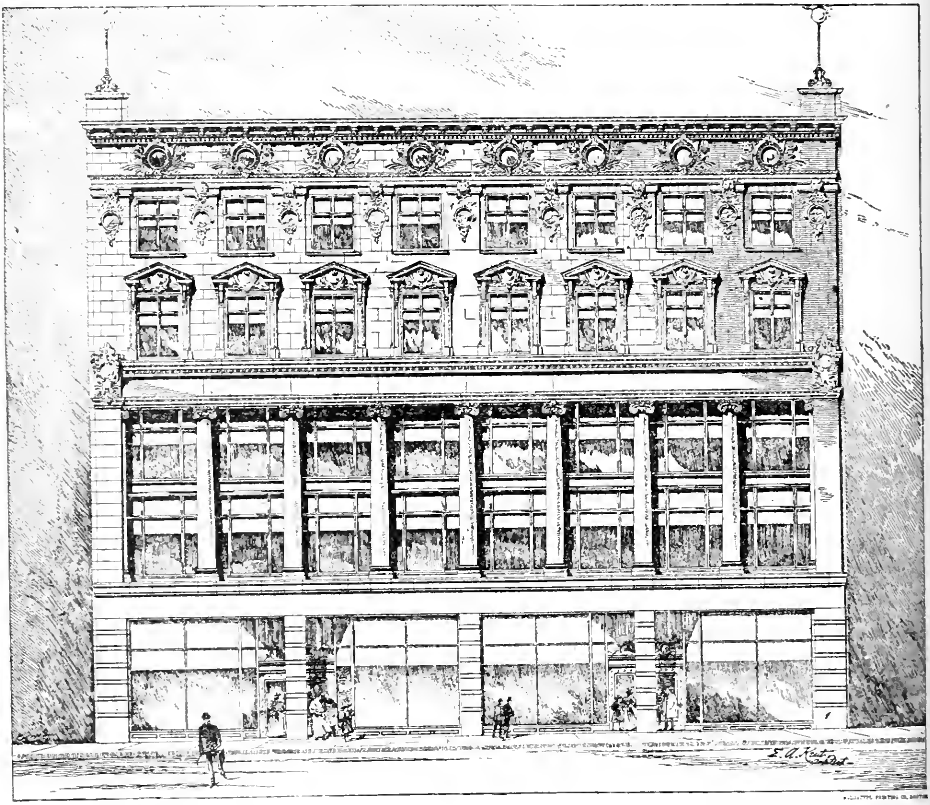
Such criticism as has been directed towards it has been based on the highly-enriched and narrow Broadway front. On all hands, even by those who do not follow the classic school so admirably represented by Mr. Hastings, the larger front on Fulton street is conceded to be one of the most notable successes in commercial architecture. That the art of this front is to a certain extent applied, and in no way helps the building structurally, is more than offset by its fine proportions, its studied harmony, its refinement, and its art. Of the Broadway front Mr. Ferree tells us that its richness was demanded by the gentleman for whom the building was erected, and his architects, therefore, had no other choice than to follow his directions.

The Mail and Express Building is not the masterpiece of Mr. Hastings; that distinction belongs to his magnificent Ponce de Leon hotel at St. Augustine,—a work of marvellous merit, and the more astonishing because it was done at the very beginning of his artistic career. But, though the Mail and Express Building is not his most successful work as a whole, it illustrates, in a very marked degree, the scope of his art. Mr. Hastings's temperament is emphatically artistic, and he is thoroughly in earnest. Those who enjoy his confidence—and a more open-hearted man does not live—know that again and again he has sacrificed valuable time that he might himself carry out the wishes of his client, where a less enthusiastic man would have delegated the details to an assistant.

The love of his art spurs him on to constant effort; his enthusiasm is boundless; his scholarship and his learning, his conscientious care, his familiarity with his art, and his earnestness make an intense personality that already, at the beginning of its career, has become one of the most interesting and noted figures in American architecture.

It need hardly be said to those who have watched the artistic progress of Mr. Hastings that he is committed to the French school first, last, and all the time. But his adhesion to it is heart-whole, and the result of profound conviction of truth. Mr. Hastings is easily the most eminent practitioner of French artistic forms in America, yet he would himself be the first to deny their French character and to insist on their supreme modernity. His forms are his faith, though it is but simple justice to him to say that he would deny that he follows forms, claiming, rather, to practise principles. Whether principles or forms, —and the difference is intrinsically important,—it is of more moment to remember his abiding faith in his artistic convictions. Mr. Hastings follows the French school, not because it is a fad of the day, not because it is easier to design under its system than when every idea must be originated by the architect, not because certain grandiose effects can be obtained in French architecture more readily than in others, not even because he happened to be trained in the École des Beaux Arts, but because a deep study of architecture has convinced him of the reasonableness of his faith, its soundness, its value, and its availability in our own day.

One may not agree with Mr. Hastings in this, but it is impossible to ignore his enthusiasm, and it is difficult to resist the fascination of his art. Mr. Hastings's enthusiasm permeates all his work, and it does not diminish its scholarly value or detract from its refinement. And, if he sometimes, as in parts of the Mail and Express Building, does things he ought not to do, he does them with such candor, and surrounds them with so admirable art, as to compel admiration from those who cannot follow him in his chosen field.



THE OTTO STORE BUILDING, BUFFALO, N. Y. E. A. KENT, ARCHITECT.

[From American Architect.]

Architecture in Australia.

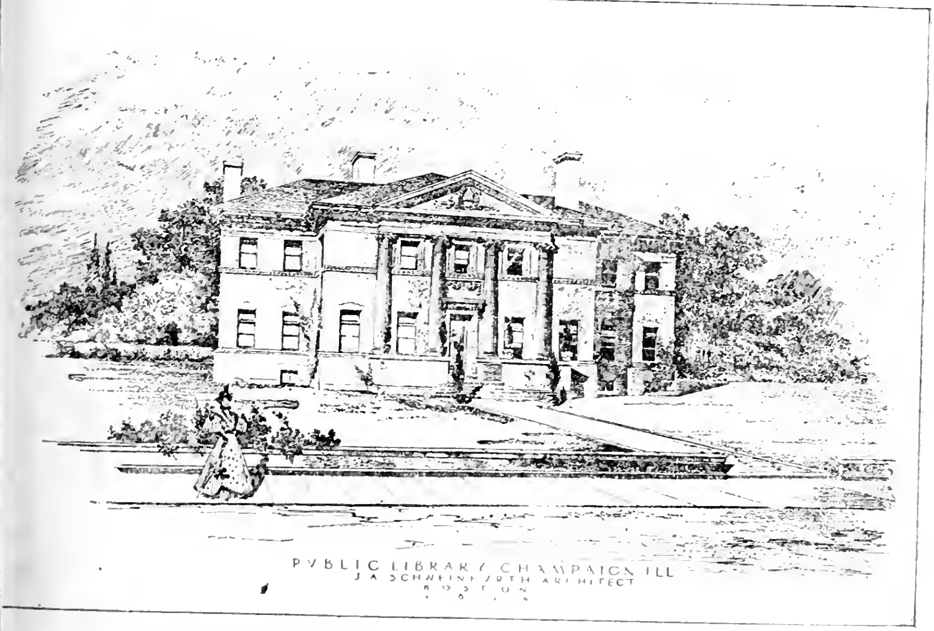
A RATHER gloomy picture of the present condition of architecture in Australia is drawn by *The Architect* (April 17) from the annual summary in the *Year Book of Australia*. The problems presented to the architects of that continent appear very similar to those which come before American architects, the more important buildings being commercial in their nature, or else dwellings of a suburban or semi-suburban character. It is generally recognized that the standard of public taste is advancing, when measured by the work done ten years since, as well as the skill of the architects; but few opportunities occur for expressing this progress, owing to the utilitarian character of many of the more important buildings.

It will be noted that this is precisely the condition of architecture in America today, though here we have larger opportunities, and commercial architecture has advanced to that point where large expenditures are made for purely artistic effects in buildings of this class. The parallel between the two countries will doubtless continue for many years to come, and in both the absence of historical precedents at home must hinder rapid advances. New South Wales continues to be the seat of the great building activity, and much is looked for from the resuscitation of the New South Wales Institute of Architects, which started afresh last year. *The Architect* states that there are few architects whose business in the past year exceeded $100,000, and that the government contracts in this colony, which the year before exceeded $1,000,000, were last year, not two-thirds of this.

Illustrations of the Month.

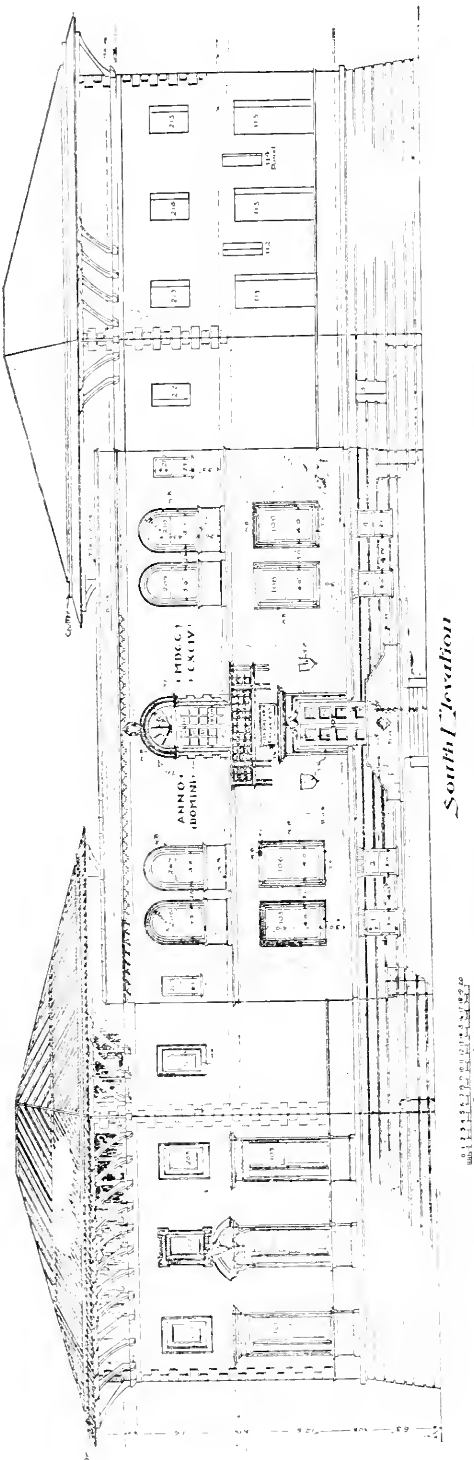
THE most important building illustrated in the April technical papers was the new design. It has an impressive front, with a pavilion at either end, whose high roofs with their rich gables admirably harmonize with the roof of the center, astride of which is a gracefully-designed cupola. The leading features of the design are a series of arches between piers below, large rectangular windows separated by Corinthian columns in the upper story, and a series of rich gables above the main cornice. It is extremely well composed, and is altogether a most interesting building.

The most admirable thing in this design is its essentially French character. It is



PUBLIC LIBRARY, CHAMPAIGN, ILL. J. A. SCHWEINFURTH, ARCHITECT.
[From American Architect.]

iairie for the tenth arrondissement of 'aris, a fine photograph of which is pubshed in *The Builder* for April 11, and levations and details of which appear in ie *American Architect* of the same date. *'he Builder* likewise prints an illustration f a superb sculpture relief, entitled "The riumph of the Republic," by M. Dalou, hich is placed in one of the receptionoms of the new building. This strucre appears to be one of the most notable lditions to recent public buildings in aris, and is a fine type of modern French typically French and, one might almost say, typically Parisian. It is quite possible that this design will, ere long, reappear in one form or another, in some American building; but in such a case it will cease to have its most distinguishing characteristic. It is often contended that it is better to copy a good design than to originate a poor one, and there is a certain amount of speciousness in the assertion, though it should first be shown that it is impossible to employ architects capable of originating good designs. American archi-

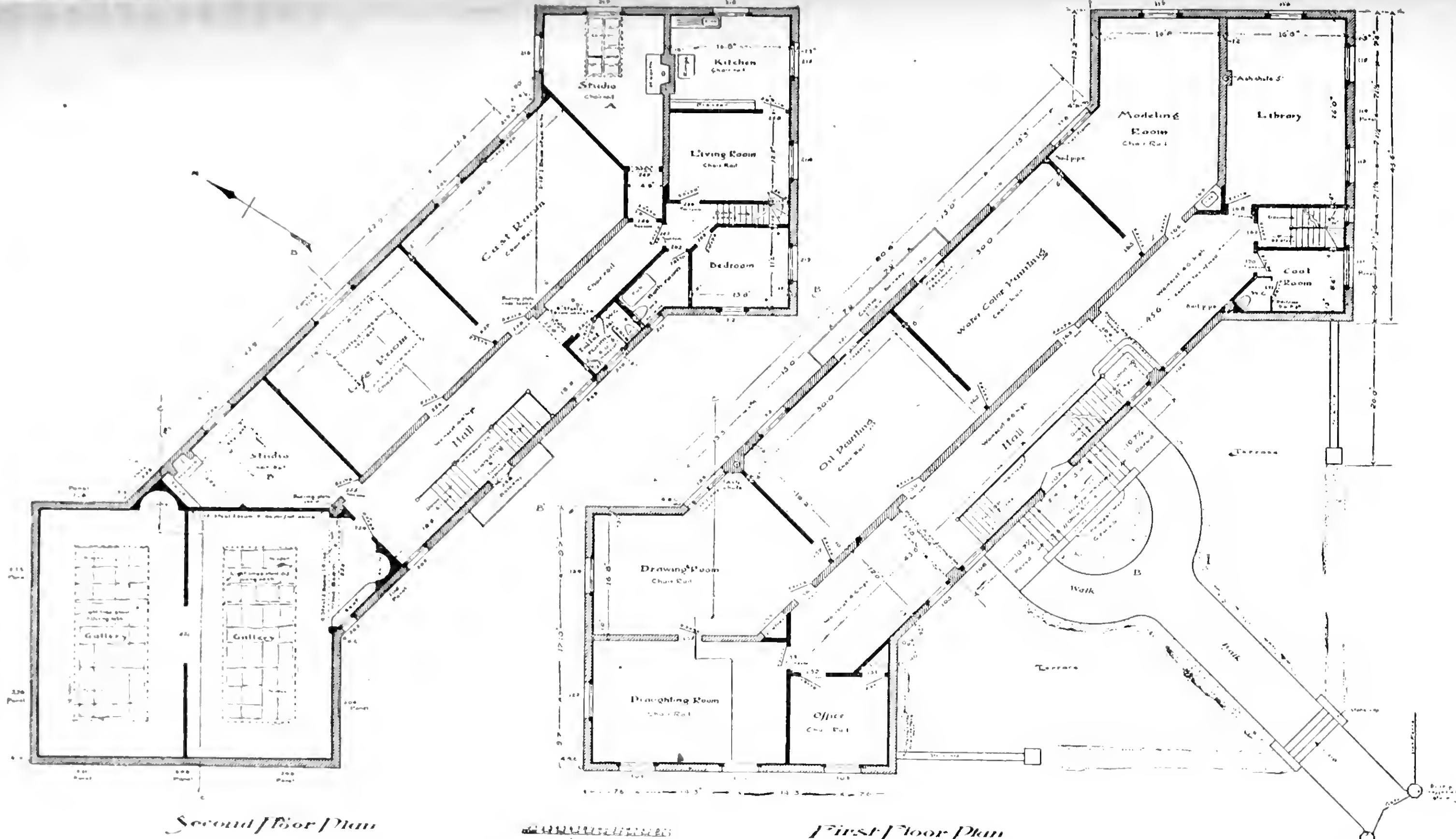


ART BUILDING FOR H. SOPHIE NEWCOMB MEMORIAL COLLEGE, NEW ORLEANS, LA. WILSON EYRE, JR., ARCHITECT.

[From the Brickbuilder.]

tects—or, rather, certain American architects—are at present the only class of professional men who seem to regard deliberate copying as something to be commended. A building like the new *mairie* shows what excellent things are sometimes produced by those trained in the École des Beaux Arts at home. It is only when such designs are transplanted to America that they lose their significance and become absurd.

A very different design is that for the new public library at Champaign, Ill., which is another in the long series of so-called classic library buildings now going up in all parts of the United States. It is a simple enough design and quite free from affected mannerisms, though it must be confessed that the drawing scarcely gives the impression of a library building. Much less successful in the application of classic ideas is the Otto store building in Buffalo, N. Y. There is an abundance of window space, as was necessitated by the conditions of the problem, but it is not artistically managed. Two of the main piers in the first story stand free before the entrances, and are mere props to support the vast lintel that stretches wholly across the building. In the next two stories the wall space is simplified by being suppressed altogether Ionic columns supporting anothe lintel or entablature. At the thir floor the wall really appears as a wall, but only for a brief space, fo the fifth floor is a narrow attic, wit rather meaningless circular win dows. It is impossible to find her any elements of success, thoug there is an abundance of classi material. With this may be groupe the Hancock Building in New Yor (*Architecture and Building*, Apr 25). The proportions are very ba for, while it is only seven stori high, the basement floors consum three of them. Ionic column



ART BUILDING FOR H. SOPHIE NEWCOMB MEMORIAL COLLEGE, NEW ORLEANS, LA. WILSON EYRE, JR., ARCHITECT.
[From the Brickbuilder.]

widely spaced, divide the fourth, fifth, and sixth stories into bays, and a frieze story, not an attic, surmounts the whole. The wall space is handled with considerable success, though the piers of the first two stories are narrower than that above them; but it is impossible to believe that the classic orders were in tended to be used in the way they have been in both these buildings.

Still another type of the current use of classic ideas is shown in the Art Building and may be profitably studied by students of classic art in its modern interpretation. The plan is a striking one,—two rectangular pavilions connected by a diagonally-placed center, an arrangement which gives a delightful variety to the silhouette and adds materially to the success of the design.

An extremely effective design, with relatively simple materials (*American Architect*), is the dormitory and apartment block for the estate of F. D. Jordan. The

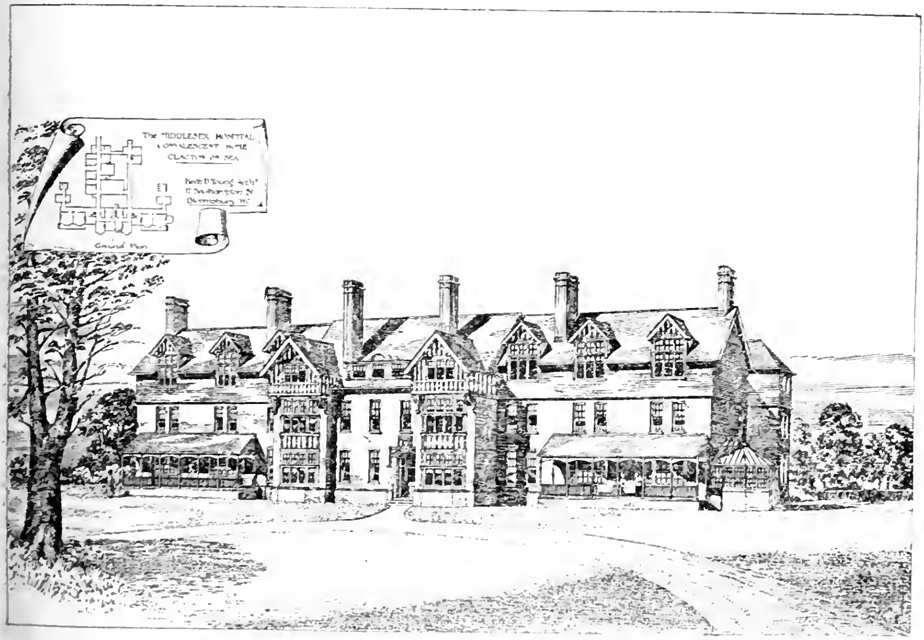
REFECTORY, HOFFMAN HALL, GENERAL THEOLOGICAL SEMINARY.

[From Architecture and Building.]

for the H. Sophie Newcomb Memorial College in New Orleans. It was designed by Mr. Wilson Eyre, Jr., and, while essentially classical in detail, is full of that poetry and individuality which this architect has so long accustomed us to find in his work. And this means that, while classic ideas—of the Italian Renaissance, by the way—are employed, they are used so freely as to convey no sense of copying. It is a highly original and interesting piece of design, plan is a hollow rectangle, with a curved line on one face that is ingeniously used in the court within. There is an utter absence of pretence in this design, which is extremely straightforward, yet amply expressive of its purpose. The General Theological Seminary in New York is gradually acquiring one of the most picturesque groups of buildings in that city. The interior of the new refectory well illustrates the type of scholastic Gothic in which they are designed, and which has been admirably employed throughout.

Among the many illustrations in the superb international edition of the *American Architect* special reference may be made to the measured drawings of Trinity Church, New York. The complete want of historical monuments, in the artistic sense, in this country renders the study of measured work almost impossible for our architectural students. Recently, however, Prof. Ware of Columbia University hit upon the happy idea of measuring up the older buildings in New York, and the present drawings of Trinity are a part of the fruits of his work in this direction. The drawings are supplemented by gelatine photographs. It is to be regretted that the very complete illustration of this historic church which this promises to furnish is not supplemented with a historical text. One week's illustrations of this paper are made up of a series of well-selected types of wrought-iron work.

Some unusually well-printed photographs have been published in *Architecture and Building*. The Syndicate Building in New York is a large commercial structure, which, at the time it was planned, was, it was publicly announced, destined to revolutionize the art of design in high buildings. Now that the building has been completed, it is apparent that nothing of the sort was accomplished. Strong vertical lines are obtained in the superstructure, but an entresol story is needlessly introduced between it and the basement, and the attic, which appears to be inevitable in New York, surmounts the cornice. Large Ionic columns are rather unhappily substituted for piers in the basement. A photograph of Phelps' Hall, Yale University, deserves notice as a successful instance of collegiate design.



THE MIDDLESEX HOSPITAL CONVALESCENT HOME.

[From the Builder.]

The *Inland Architect* publishes its usually well-chosen selection of buildings, the most important being the accepted design for the new library and museum building for the State Historical Society of Wisconsin at Madison. This is an extremely stately design, with a long colonnade extending through the second and third stories, enclosed within strong pavilions at the end. Below is a basement, and above a high balustrade. The design keeps well within traditional ideas. Quite in contrast is a design for the Crawford county court house in Indiana, of a Romanesque type of architecture that seems almost antiquated, so completely are our architects running to the classic.

In addition to Mr. Eyre's design, commented upon above, the *Brickbuilder* publishes an elevation of the Garden City Hotel at Garden City, Long Island, by McKim, Meade & White,—an unpretentious enough design, eminently suited in its simplicity for its location and purpose.

The most notable illustrations in *The Builder* this month are of ecclesiastical buildings. Its very valuable series of drawings of the abbeys of Great Britain is continued with Abbey Dore, and in modern work special interest attaches to some very complete illustrations of the chapel in Douglas Castle, including many details. A Wesleyan chapel at Blaina, Mon., is an interesting design, with a rather happily managed ecclesiastical effect that is sufficiently marked, and yet not of that church type of architecture generally seen in the buildings of the Established Church. Elevations and sections of Mr. Belcher's competition design for the Royal Insurance Buildings in Liverpool, commented on in these pages last month, are also published, together with an important country-house by the same architect.

Of the photographs published in *The Architect* the most important are of the New Craig House, Morningside, N. B., a very large country-house, extremely well composed, though offering considerable variety in its parts.

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IRON WORK.—Six sheets of ornamental wrought iron work, old and new, Amer. Archt , April 4.—Gate for Mrs. V. Hotz, Rechberg, Zurich, Inland Architect, April.

LIBRARIES.—Design for a Public Library, by P. E. Newton, Amer. Archt., April 11.—Public Library, South Audley street, London, by A. J. Bolton, ibid.—Public Library, Champaign, Ill., by J. A. Schweinfurth, ibid., April 25.—Free Library, Willesden Green, England, by Newman & Newman, Architect, Apr. 24.—Accepted Design for Library and Museum, State Historical Society of Wisconsin, Madison, Wis., by Ferry & Clas (with plans), Inland Archt., April.

MISCELLANEOUS.—"The Examiner" Bear Pit, Gate Park, San Francisco, Cal., by W. Polk, Amer. Archt., April 25.—Pumping stations (3), by G. King, Archt. and Build., April 11.

MONUMENTS.—Argyll Monument, St. Giles' Cathedral, Edinburgh, by S. Mitchell & Wilson, Amer. Archt., April 11.—Bishop Hobart's Monument, Trinity Church, New York, by B. Hughes, ibid., April 25.—Relief ("Triumph of the Republic") in the new Mairie, Paris, by M. Dalou.

MUSEUMS.—Art Building for H. Sophie Memorial College, New Orleans, La., by Wilson Eyre, Jr. (elevations and plans), Brickbuilder, April.—Accepted Design for Library and Museum, State Historical Society, Madison, Wis. (with plans), by Ferry & Clas, Inland Archt., April.

PUBLIC BUILDINGS.—(Mairie du Xme Arrondissement, Paris, by M. Rouyer, elevation and details) Amer. Archt., April 11; general view of same in Builder, April 11; also Sculpture Relief by M. Salon.—Design for West Ham Technical Institute and Library, by Newman & Newman, Amer. Archt., April 18.—Rear Entrance of Alleghany Court House, Pittsburg, Pa., by H. H. Richardson, ibid.—Design for New County Buildings, Durham, England, by Essex, Nicol and Goodman, ibid.—Competition Design for New City Hall, New York, by Godron, Bragdon & Orchard, ibid.—Competitive Design for Minnesota State Capitol, by E. Flagg (View plan and section), Archt. and Build., April 4.—Competition Design for Public Baths, Wash-Houses, etc., Shoreditch, E. London, England, by W. C. Howgate, Architect, April 10.—Another, by Hannaford & Wills, British Architect, March 27.—Court House for Crawford County, Indiana, by O. W. Marble, Inland Archt , April.

SCHOOLS. — Dori Dormitory and Apartment block for estate of F. D. Jordan, by Ball & Dabney (with plan and views), Amer. Archt., April 11.—Design for West Ham (England) Technical Institute, by Newman & Newman, ibid., April 18. —Pembroke Academy, Pembroke, N. H., by W. M. Butterfield, ibid., April 25.—Yorkshire College, Leeds, Eng., by A. Waterhouse, ibid.—Phelps Hall, Yale University, New Haven, Ct., by C. C. Haight, Archt. & Build., April 11.—Proposed High School building, Middletown, Ct. (alternate design), by F. A. Comstock, ibid.—Refectory, Hoffman Hall, General Theological Seminary, New York, by C. C. Haight, ibid., April 25.—University Preparatory School, Ithaca, N. Y., by W. E. Greenawalt, ibid.—Westmoors School, Dorset, England, by Adye and Adye, Architect, April 3.—Art Building for H. Sophie Newcomb Memorial College, New Orleans, La., by W. Eyre, Jr., Brickbuilder, April.—Design St. Boniface Parish School and Hall, Chicago, by Schlachs & Ottenheimer, Inland Archt., April.

STUDENTS' WORK.—Side doorway in west front of cathedral, Borgo, San Dominico, Brit. Archt., March 27.—Design for an Institute of Architects, by C. H. Quennell (with plans and sections), ibid., April 3.—Another by P. E. Newton (with plans and detail), ibid., April 10.—Another (view, elevations, plans, sections), by J. B. Fulton, ibid., April 24.

Leading Articles.

*5270. Restraints Upon the Practice of Architecture. John Beverley Robinson (Showing the injurious effects of compulsory esthetic standards). Eng Mag–May. 2100 w.

*5287. Hotel Cecil (A brief description of some features of this fine hotel, being built on the Thames embankment). Plumb & Dec–April 1. 1700 w.

5324. The Art of Fireproofing. Herman B. Seely (An illustrated discussion of methods and principles, value of materials used, protective coverings, etc). Eng News–April 9. Serial. 1st part. 3600 w.

*5339. Brickwork Tests of the Royal Institute of British Architects (Abstracts of papers by Messrs. William C. Street, Max Clarke, Matt Garbutt, and Prof. Unwin, with editorial. Account of experiments, etc). Builder–April 4. 6000 w.

*5340. Austin Friars and Its Cloister. Allen S. Walker (A brief summary of the history of the Austin Friars' Church and Monastery, with an account of recent discovery which has thrown some light upon the original buildings). Builder–April 4. 2800 w.

*5341. Abbey Dore. R. W. Paul (Descriptive article with sketches of details). Builder–April 4. 4000 w.

5342. A Paper on Contracts. T. M. Clark (Read before the students of the Architectural Department of the University of Pennsylvania. The great principle which underlies the making of contracts is that they must have a consideration). Am Arch–April 11. 5800w.

*5351. The Edinburgh Royal Observatory (Some interesting details of its design and construction, as given in the *Scotsman*). Brit Arch–April 3. 1300 w.

5387. An Extensive Fire Apparatus Station, New York (Illustrated description of the engine-house, corner of Elm and White Sts., New York. The aim has been to make it as perfect as possible in all its appointments). Eng Rec–April 11. 1800 w.

5430. Durability and Decay of Timber (Extract from Bulletin No. 10 (Timber) of the U. S. Department of Agriculture. A study of the conditions affecting the durability of wood.) Arch & Build–April 18. 1400 w.

5431. The Housing of the Poor. Ill. (The facts stated in this article are taken almost entirely from the Eighth Special Report of the U. S. Commissioner of Labor, and are quoted as directly as is consistent with the connection of ideas). Am Arch–April 18. Serial. 1st part. 2500 w.

*5441. A Further Note on the Brickwork Tests. H. H. Statham (Editorial suggestions of methods of bonding to determine strength). Builder–April 11. 1800 w.

†5487. Saint-Pierre-ès Liens; The Ancient Cathedral of Geneva. Louis Viollier and Lawrence Harvey (Read at the general meeting of the Royal Inst. of Brit. Arch. Mr. Viollier's paper is written in French, with translated abstract by Mr. Harvey, and is illustrated. Mr. Harvey's paper is a careful illustrated description of this building, with some account of the history of Geneva. Discussion of papers also). Jour Roy Inst of Brit Arch–March 19. 13500 w.

†5488. Practical Lessons Derived from the Modern Use of Terra-Cotta. J. Miller Carr (Read before the Manchester Society. The use by the present generation, and chiefly in England). Jour Roy Inst of Brit Arch–March 19. 4300 w.

*5502. The New Royal Observatory, Edinburgh (Illustrated description). Engng–April 10. Serial. 1st part. 3800 w.

5537. The Shepard Memorial Church (Brief illustrated description of the Scarborough Presbyterian church). Arch & Build–April 25. 500 w.

*5540. Notes on an Architectural Tour in England and France. W. A. Langton (Descriptive only of new work). Can Arch–April. 2100 w.

5562. Metal Stair Design. Karl Burghardt (Illustrated description of typical structural details in metal stair work, now so much in demand in the construction of fire-proof buildings). Eng News–April 16. 2800 w.

5566. The Efficiency of Modern Fireproof Building Construction (A discussion of the question of fireproofing and protective construction, reviewing recent papers on the subject, with a view to indicating wherein our best building construction fails, and how it may be improved in respect to its resistance to damage and destruction from fire). Eng News–April 16. 3000 w.

5567. The Danger of Square Cast-Iron Columns. John F. Ward (Condemning the use of square columns and giving reasons for so doing). Eng News–April 16. 700 w.

†5639. Paraboloid Sound Reflector at the

Senate House, Calcutta (Descriptive of the construction of a device for improving the acoustic properties of the Senate Hall, which was most successful and is recommended). Ind Engng-March 21. 900 w.

*5641. The Smaller Houses of the English Suburbs and Provinces. Banister Fletcher (An article illustrating and describing current practice and requirements in Great Britain). Arch Rec-April-June. 6400 w.

*5642. City Apartment Houses in Paris. Ill. Maurice Saglio (Description of French apartment houses, with short account of the tendencies of French architecture, and the principles which govern the construction of these houses). Arch Rec-April-June. 6000 w.

*5643. Japanese Architecture. C. T. Mathews (An interesting account of the history, domestic dwellings, palaces, castles, houses of the territorial nobility, ecclesiastical architecture, Buddhist temples, &c). Arch Rec-April-June. 5000 w.

*5644. Cyrus L. W. Eidlitz. Montgomery Schuyler (A very interesting illustrated description of work of this prominent architect, with brief biographical sketch). Arch Rec-April-June. 7500 w.

*5645. Characteristics of French Gothic (Editorial review calling attention to the artistic imagination and poetic conception of the French architects of the thirteenth century). Builder-April 18. 2000 w.

*5649. Architectural Rendering in Pen and Ink. Ill. D. A. Gregg (Phases of the work, with suggestions from an artist of sixteen years of practice). Brickbuilder-April. 1600 w.

*5650. Notes on Design of Brick Buildings. George F. Newton (The importance of the appreciation of opportunities and possibilities; choice of material; knowledge of theories formed from the study of successful buildings, &c). Br. Builder-April. 2300 w.

*5651. Architecture in Australia. From the *Year Book of Australia* (The year just ended is considered one in which architectural conception has been almost entirely absent. The work completed during the year is reviewed and somewhat criticised). Arch, Lond-April 17. 2200 w.

*5767. The Architect's Use of Color (Extract from papers read at the Inst. of British Architects by Halsey R. Ricardo and Christopher Whall, with editorial. The necessity of architects acquiring a more practical acquaintance with materials and their possibilities in the way of color treatment). Brit Arch-April 24. 2700 w.

*5768. Rood and Other Screens in Devonshire Churches—Past and Present. Harry Hems (The paper deals with churches that have lost their screens, stone screens missing, existing stone screens, churches in which a few remains of oak screens exist, good screens, Devon's best screens, some restored screens, and some new screens in old churches). Brit Arch-April 24. 9500 w.

5837. Preliminary Foundation Tests for the St. Paul Building (This building being erected at Broadway and Ann streets, New York, has an unusually great ratio of height to width, so that any slight settlement might be of a serious nature; hence the necessity of great care in foundations. The report of expert engineer's tests is given). Eng Rec-May 2. 700 w.

*5839. Brickwork Tests: Report on the First Series of Experiments. William C. Street and Max Clarke (Paper read at meeting of Royal Inst. of Brit. Archs., illustrated, and followed by notes, statistics and discussion. The tests were made for the purpose of ascertaining the amount of resistance possessed by brickwork under great crushing loads). Jour of Roy Inst of Brit Arch-April 2. 10000 w.

*5840. Carved Woodwork in Spanish Churches (Editorial discussion, dealing specially with the woodwork, but giving some general information of interest. There are numerous illustrations of the wonderful carving). Builder-April 25. 2200 w.

*5841. American Floors. F. Maire (An article condemning the use of carpets tacked down, and claiming that their use is due to the poor flooring laid. Presenting the subject from the healthful and cleanly standpoint). Ill Car & Builder-April 24. 1200 w.

*5842. A Typical Americal Dwelling (Illustrated description of the residence and stable of Mrs. Kathleen Martin, at Mountain Station, N. J). Ill Car & Build-April 24. 700 w.

5915. The St. Paul Building, New York City (Illustrated description). Eng News-May 7. 3000 w.

†5916. The First Prize Design for New Premises, Bank of Madras, Submitted by "Hope." S. S. Jacob (Illustrated description, with plans, specifications and abstract of estimated cost). Ind Engng-April 4. 2000 w.

5921. Stable Construction for a Country Estate (Plans and details of the stable and coach-house built for W. F. Havemeyer on his estate at Seabright, N. J. Illustrations of ground plan, elevation and section). Eng Rec-May 9. 1000 w.

5923. Notes Upon the Architecture of China. F. M. Gratton (Abridged from a paper read before the Roy. Inst. of British Architects. Historical account of cities, walls, temples, &c., in this first part). Arch & Build-May 9. Serial. 1st part. 3800 w.

5924. History of the United States Capitol. Glenn Brown (Account begins with the selection of the site and carefully reviews all points of interest connected with the preparation for building, the plans submitted, and final selection in this first number). Am Arch-May 9. Serial. 1st part. 3000 w.

†5927. The Scientific Construction of Chimneys. H. J. Palmer (From *The Builders' Journal*. A consideration of the laws and principles of good draught, and other points of importance in chimney construction). Ind & East Eng-April 11. 1700 w.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

Mississippi Improvement by Contract.

MR. COPPÉE'S article on "Bank Revetment on the Mississippi" will give the readers of THE ENGINEERING MAGAZINE an additional interest in the proposal to take a part at least of the improvement work out of government hands, and place it with private contractors.

The passage of house bill No. 2,779 would give to Isaac M. Mason, W. M. Samuel, and their associates the contract for improving the channel from St. Louis to Vicksburg for the sum of one million dollars per annum for a period of twenty years.

This proposition, says *Engineering News*, has called out "some very pertinent remarks upon the same subject by Mr. Henry Flad, past-president of the American Society of Civil Engineers and a member of the Mississippi river commission. Mr. Flad says, first, that the efficiency of movable dykes is still problematical, as none have been tried on the Mississippi river. They might be successfully used in closing channels and in directing currents; but on long bars they would simply cause the removal of sand from one place to deposit it at another lower down. Some other devices mentioned in the bill are also equally doubtful in practicability, and some have been tried and found to fail in all save exceptional cases.

"On the other hand, dredges have been fully and successfully tried in this work. They take up the sand and actually remove it to points remote from the channel, and where it can not be returned by the current of the river. Dredges have the advantage over jetties and movable dikes of being able to begin work before the river has reached its lowest stage; as the dredge 'Alpha,' belonging to the commission, can work at 12 feet below the surface, the dredge 'Beta,' at 20 feet below, and the new dredges to be built can operate at 15 feet. The capacity of these dredges already in hand is 600 cubic yards per hour for the 'Alpha' and over 5,000 cubic yards per hour for the 'Beta.' Mr. Flad believes that these two dredges would be sufficient to keep the river free from obstruction by bars from Cairo to Memphis, and provide a channel 250 feet wide and 9 feet deep throughout.

"Messrs. Mason & Samuel propose a channel only 6 to 7 feet deep and 100 feet wide above Cairo, and 150 feet wide below Cairo. This width, Mr. Flad declares, is entirely insufficient for the safe passage of boats. For the above work Messrs. Mason & Samuel would receive, under the bill, $600,000 per annum for creating and maintaining a channel 7 feet deep and 150 feet wide up to Cairo, and $400,000 per annum for a channel 100 feet wide and 6 feet deep from Cairo to St. Louis. For each additional foot of depth secured they would receive $50,000 per year above Cairo, and $100,000 per year below Cairo. Mr. Flad points out that in 1882 and 1885 the lowest water in the river was never below 8 feet, and in 1890 it was never lower than 10 feet. This may occur in the next twenty years; and under similar conditions the contractors would receive a bonus of $200,000 for the two years of 8 feet depth, and $300,000 for the one year of 10 feet; adding the stipulated annual sums, the contractors would receive $1,800,000 plus $500,000, or $2,300,000, in these three years, without incurring any outlay whatever except for the maintenance of plant and for watchmen.

"Mr. Flad then contrasts this exhibit with the work to be done by the Mississippi river commission under its present organization. He finds fifty crossings between St. Louis and Cairo, and fifty-three between Cairo and Vicksburg, on any of which bars may appear and obstruct navigation. He then has a profile made, on the basis of the low-water season of 1895, and figures the total probable quantities of excavation as follows: above Cairo, channel 100 feet by 6 feet, 55,220 cubic yards;

for a channel 250×9 feet, 1,471,420 cubic yards. Between Cairo and Vicksburg, for a channel 150×7 feet, 222,786 cubic yards; for a channel 250×9 feet, 1,682,520 cubic yards.

"He estimates that, with an average capacity of 800 cubic yards per hour, 7 dredges and dredging plants would be needed between St. Louis and Cairo, and 9 dredges and plants from Cairo to Vicksburg. If channels of the depth and width proposed by Messrs. Mason & Samuel are to be secured, sets of 3 and 4 dredges of the same capacity would do the work. Mr. Flad estimates the cost of one dredging-plant of 800 cubic yards' capacity as follows:

One dredge	$100,000
One pile-sinker	5,000
One tender	25,000
One surveying-launch	1,000
One fuel-flat	1,000
Total for one plant	$132,000

"The cost of operating one such dredge and plant, as fixed by one year's experience with the 'Alpha,' is $5,500 per month. For one year's work about Cairo, on the plan proposed by the commission, the cost would be $214,500; to this is added 10 per cent. of the first cost of the plant for renewals and repairs, making $306,900 for the total cost of operation for all dredges for one year, or $6,138,000 for twenty years. From Cairo to Vicksburg, on a similar basis, the cost of operation would be $349,800 per year, or $6,996,000 for twenty years.

Applying the same assumptions to the plan of Messrs. Mason & Samuel, the operating expense of their dredges above Cairo for one year would be $127,600, with the ten per cent. added, or $2,552,000 in twenty years. From Cairo to Vicksburg the annual cost would be $157,300, or $3,146,000 for twenty years. Mr. Flad summarizes these two exhibits as follows:

Channel 250×9 ft. above and below Cairo.

First cost:

St. Louis to Cairo, 7 dredges and plants at $132,000	$ 924,000
Cairo to Vicksburg, 9 dredges and plants at $132,000	1,188,000
Operating expenses for twenty years, as above: St. Louis to Cairo	6,138,000
Cairo to Vicksburg	6,996,000
Total	$15 246,000

Channel 100×6 ft. above Cairo, and 150×7 below Cairo.

First cost:

St. Louis to Cairo, 3 dredges and plants at $132,000	$ 396,000
Cairo to Vicksburg, 4 dredges and plants at $132,000	528,000
Operating expenses, for twenty years, as above: St. Louis to Cairo	2,552,000
Cairo to Vicksburg	3,146,000
Total	$6,622,000

"If Messrs. Mason & Samuel would carry out their contract for twenty years, they would receive $20,000,000 for work costing at most $6,622,000."

If, however, as is very likely, navigation interests should demand a larger channel, and the contractors should "conclude to adopt and maintain the channels proposed by the commission, they would receive the $20,000,000 plus a bonus of $7,000,000 for the 3 feet additional depth above Cairo and the 2 feet additional below (at $50,000 and $100,000 per annum per foot). This would make the cost $11,754,000 more than the same work could be done for by the commission; the relation being as $27,000,000 is to $15,246,000, or an excess of nearly fifty per cent. in cost.

"Since the above estimates were prepared, Messrs. Mason & Samuel have increased their proposed channel width to 200 feet above and 250 feet below Cairo. This would increase their expenditure in twenty years about $10,000,000, and reduce their profit to about the same sum. As it would be difficult to determine whether or not the terms of any contract were fulfilled, the employment by the government of a considerable number of surveying parties and inspectors would be necessary. This would involve extra expense, which should properly be considered, with any contract plan."

This last consideration, though minor, is not unimportant; altogether the expediency of the change seems dubious.

Seepage Waters from Irrigation.

THIS branch of irrigation hydraulics has been the subject of some most thorough and valuable work by Prof. Carpenter and his associates, of the State Agricultural College, at Fort Collins, Colo. The results are exhibited in Bulletin No. 33 of the agricultural experiment station, and are abstracted by the *Engineering Record;* they are obtained from a study of the valleys of the Cache à la Poudre and the South Platte rivers.

"The lands artificially supplied with waters in these districts are not sensibly different from much of the irrigable lands of the southwest in being of a sandy, or, to some extent, gravelly, nature beneath the surface. Irrigation has been practised in the fields of observation from two or three to thirty-five years, and the areas under consideration are about 130,000 acres in the Poudre Valley and 75,000 to 80,000 acres in that of the South Platte.

"One of the most important of the questions that have arisen in connection with the subject of irrigation is that of the return seepage or flow of the water from the distributing canals to the streams from which it is taken, for it has direct bearings, not only upon the irrigating capacity of the stream, but also on some essential legal questions connected with the rights of the up-stream water-takers. There is nothing new in the character of the questions involved, for they long have attracted attention among engineers in the irrigation field; but we believe that few or no other efforts have been made toward solving the problems involved so systematic and thorough as those put forth in Colorado. Both the Cache à la Poudre and the South Platte have distributing canals leading from them at different points in their courses, and thus lend themselves admirably to the gaging observations, which extend over a distance of two hundred miles and more, requisite for the work undertaken. When it is remembered that the quantity of water required for the purposes of growth of one pound of dry vegetable product may be estimated roughly at three hundred to three hundred and fifty pounds, it readily may be appreciated that large excesses of water over the actual needs of vegetation are supplied in the ordinary processes of irrigation, and it becomes a matter of great practical importance to determine where it goes to.

"The gagings were carefully made with current meters and floats at the points where the irrigating canals joined the river, both in the river and in the canals, thus establishing the volumes of flow in both. Similar observations were also made at various points in the canals. A comparison of these results showed how much volume was gained or lost between any two consecutive points of observation either in the river or in the canals, and thus enabled the amount of return flow or seepage to the river to be determined. This quantity per mile of river course naturally varies widely with the topography of the country adjacent to the river and with the quality of its material, as well as with the adjacent irrigated area, and with the temperature of the sub-surface material through which the water must flow. The gain in volume for the Cache à la Poudre river was found to rise as high in one instance as 17.09 cubic feet per second per mile of progress down stream, with, of course, some losses. For the South Platte the average gain in volume per mile of progress down stream ranged from 1.6 to 3.4 cubic feet for different months per year. Or, to put it in another way, 'the seepage from 1,000 acres of irrigated land on the Poudre river gives 1 cubic foot per second constant flow; on the upper Platte, 1 cubic foot to about 420 acres; on the lower Platte, 1 cubic foot to 250 acres.' Or again, about one-third of the water applied in irrigation on the Poudre returned to the river, and about 30 per cent. on the Platte.

"Two important results follow these determinations. In the first place, as the motion of the water is excessively slow through the sand, the seepage volume acts as a reservoir from which a practically uniform discharge into the river takes place throughout the year as a supplement to the rainfall, which has an average annual value of not more than fourteen inches in this part of Colorado; and, in the second place, the down-stream takers have available about one-third of the water taken from the river by the up-stream users. It is observed also that, as might be anticipated, the seepage continues to increase for a long period of time with the filling of an increased proportion of the sand voids. Thus the irrigation of the upper districts of the river largely augments and continues to augment for a considerable time the irrigating capacity of the river in the lower reaches of its course. These are among the more important of the results established by the observations under consideration, and that they are of practical value is evident from the fact that 'the capital value of the seepage water received in the valley of the Cache à la Poudre is not less than $300,000, and perhaps $500,000, and for the Platte it is from $2,000,000 to $3,000,000.'"

Readers of Mr. Hinckley's excellent article on "Pump Irrigation on the Great Plains," in the April number of THE ENGINEERING MAGAZINE, will find an especial interest in this report, for it suggests that the section benefited by irrigation may be much wider than the measure of the immediate surface to which the water is directly applied.

Approximate River Gaging.

IN the report of the California commissioner of public works, Mr. C. E. Grunsky has suggested a method to be used where great accuracy, special apparatus, and trained assistants are not required. The substance of this report is abstracted by the *Engineering Record* (March 7), from which we take the following description:

"In the light of the experience on the Sacramento, San Joaquin, and Feather rivers, the following method is suggested, and can be recommended for all ordinary open earthen channels not too diminutive. By means of surface floats of any pattern, not exposed too greatly to wind action, determine the surface velocity from bank to bank. By sounding, determine the cross-section of the stream at the upper end of the course over which the floats are run; also the cross-section at the lower end of the course, and the cross-section midway between these two. From these three sections determine an average section by giving double weight to the middle section, and plat the same, showing the position of the water surface at the time of the gaging. Plat above the water surface line, on any convenient scale, the surface velocities, and construct the curve of the surface velocity. Reduce all velocities indicated by this curve by multiplying by the ratio found in the following table:

Width, divided by average depth =	5	10	15	20	30	40	50	75	100
Ratio of mean velocity in any vertical to the observed surface velocity $\frac{V}{Vs}$ =	1.03	.99	.96	.94	.91	.89	.87	.84	.82

and treat the resulting curve as a curve of the mean velocity in vertical longitudinal planes. At as many selected points as seems desirable, multiply depth of water by corresponding mean velocity, scaled from the curve, and plat the product as a point on a discharge curve. When sufficient points of the discharge curve have thus been found, complete it. The area inclosed by it and the horizontal line from which discharge is platted will represent the total discharge.

"[It is not correct to divide the area of the curve of mean velocities by the width of the water surface, and to call this the mean velocity of the stream. This would only then be correct when the cross-section of the stream is a rectangle. This mistake is made by many hydraulicians. See *Handbuch der Ingenieurwissenschaften*, Part III., p. 251, for error of this character.]"

The New Railroad Bridge at Niagara.

THE railroad suspension bridge at Niagara Falls is to come down, and give place to a steel-arch structure, which is described in the *Railroad Gazette* of April 24 with specifications and drawings. The *Gazette* says:

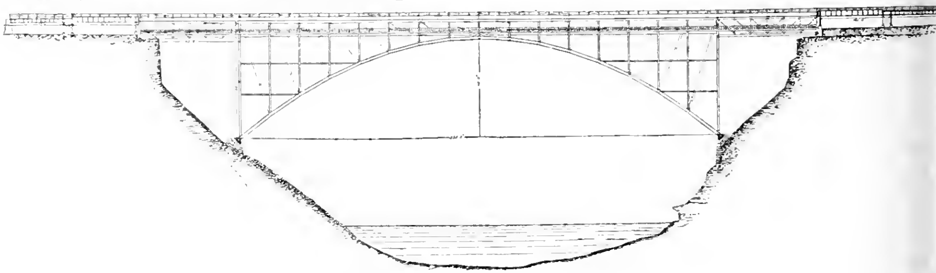
"This has been under discussion for a good while, and Mr. L. L. Buck, chief engineer for the bridge companies, prepared plans and estimates of cost some months ago. Recently an agreement was entered into between the Niagara Falls International Bridge Company and the Niagara Falls Suspension Bridge Company on one side, the owners of the bridge, and the Grand Trunk Railway Company on the other side, as the actual users of the bridge, under which work can be begun at once in building the new structure. Plans and specifications have been sent out for bids, and it is believed that work will be begun this summer.

"The existing suspension bridge was completed in 1855. It was built from the designs of Mr. John A. Roebling, and under his supervision as chief engineer. It was a very remarkable engineering work in its day, and has stood as a monument to the genius of its designer. In 1880 the suspended structure, and in 1886 the towers, were renewed, from the designs of

a batter of one horizontal to ten vertical. The width between the axes of the top chord will be 30 feet; between the axes of the rib at the crown it will be 34 feet; and between centers of skewbacks it will be 56 feet 7¾ inches. The axes of the upper chords will be 134 feet above the skewback centers, and the axes of the ribs at the crown will be 114 feet above the skewbacks. One end of each shore span will be hinged to the arch by a pin at the intersection of the end post and top chord of the arch, and the shore end will rest on expansion rollers on masonry abutments. The bed plates of the arch will rest on masonry founded on the rock.

"The bridge has two floors, the upper one carrying the railroad tracks and the lower one the highway, sidewalks, and trolley track."

"The end spans and the first panels and



NEW RAILROAD BRIDGE AT NIAGARA.

Mr. L. L. Buck and under his supervision. This work was done without interrupting traffic, and is considered to have been one of the most daring and original things ever attempted by an American engineer. Soon the record of this important work of Mr. Roebling and Mr. Buck will exist only on paper.

"Bids are called for the construction and erection of the metallic superstructure, and for the removal of the present suspension bridge and towers. The masonry foundations and the temporary anchor pits will be prepared by the bridge company.

"The bridge will have a main span 550 feet long between centers of end pins, and will be connected with the top of the bluff on each side of the river by a trussed span 115 feet long. The main span will be an arch with horizontal upper chords, hinged at the skewbacks, and each truss will have

post of each end of the arch will be erected on scaffolding. The end spans will be connected with the end post of the arch and, by means of the approach girders, with the temporary anchorage, and then the two parts of the arch will be built out by cantilevers. As the present bridge will continue in use during construction, the upper floor beams of the arch must be left out, until the old suspended superstructure can be raised high enough to permit the new beams to be inserted under the upper chords of the old structure. During this time the old structure will rest on the lower floor beams of the arch bridge, and consequently the cables of the old bridge can be taken apart or removed, and the towers can be taken down. The suspended structure must then be pushed far enough to one side to permit a track to be laid on one pair of the new stringers, after which the old superstructure can be taken apart and removed, and then the other track laid and the bridge completed. As the new bridge will have the weight of the old suspended structure and its trains to support, before the upper beams can be inserted, it is probable that the upper chords will need to be temporarily braced against the old structure, until the beams and stringers are in place. During erection it will be difficult to use a traveler, as the old bridge is in the way. It seems best to use a couple of heavy wire ropes over the towers, with trolleys to carry out the material. Cages for the men can be suspended from the old bridge wherever required.

"The bridge is designed to carry on each railroad track a load of two locomotives, with four pairs of drivers each and 40,000 pounds on each pair, followed by a train of 3,500 pounds per foot, — that is, 7,000 pounds' live load on that floor. It is designed to carry, in addition, a live load of 3,000 pounds per running foot on the lower floor, making 10,000 pounds, live load in all. It will be seen that the whole forms an unusually heavy load."

The Costliness of Cheap Engineering.

UNDER this title, *Engineering News* publishes a communication making some excellent points against the unwise and injurious methods which have been too often adopted in the management of public works of an engineering character.

Perhaps the strongest point made is the exposition of "the wrong which cities do to their own interests and to contractors by altering the plans and specifications of competent engineers to suit the funds which they have available for the work." The writer had just come from "looking at a large sewerage system which is worse than worthless. It was planned by a good engineer, but the plans were changed by one who was unworthy to unlatch his shoestrings, and the taxpayers have to suffer." His conclusion regarding the matter is thus summed up: "Our cities do need thoroughly competent and conscientious engineers as advisers—men who cannot be bought and sold. There are plenty of such men to be had. If our cities will rely on such engineers to prepare plans for their work, and allow no changes except such as these engineers may make, we should then have good public work and tricksters would not bid on it."

A Correction.

MR. E. SHERMAN GOULD'S simplified hydraulic formulæ, which appeared in this department recently, copied from the *Engineering News*, were incorrectly printed in the original publication, and a later issue of the *News* makes the correction, which is the substitution of the multiplication sign for the plus signs in the second members of the equations throughout.

The end of the quotation beginning on page 1,115 is left indefinite by typographical error in omitting the concluding marks. These should be inserted at the end of the eighth line on page 1,116. The remainder of the paragraph is not direct quotation, and the comment as to the insufficiency of the fifteen per cent. margin is the reviewer's, not Mr. Gould's.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

Bridges.

5325. The Austrian Tests of Arches. Mansfield Merriman (A brief synopsis of each of the seven chapters of the report presented by the committee appointed by the Austrian Society of Engineers and Architects to undertake a series of experiments on arches. The article is well illustrated, showing the manner of testing with explanations and results). Eng News—April 9. 2200 w.

5516. The New Railroad Bridge at Niagara (Short description of steel arch to replace the old suspension railroad bridge. Contains brief general specification of material, erection and loading). R R Gaz—April 24. 2000 w.

*5555. The New Waterloo Bridge Over the River Ness at Inverness (The piers are of cast iron cylinders and the spans steel lattice girder. It replaces the "old black bridge" built 90 years ago. The construction is fully described, and illustrated by a view of the structure). Eng, Lond–April 10. 2400 w.

5565. Trestle for Single-Track Electric Railway (Description with specifications. The bents and framing on a 350-ft. radius curve are illustrated fully). Eng News–April 16. 600 w.

5620. Cantilever Bridges (A brief abstract of Prof. Edgar Marburg's paper before the Engineers' Club of Philadelphia, the general conclusion being rather adverse to the economy of the cantilever type, except for long spans and situations where falsework is extraordinarily expensive). Ry Rev–April 25. 900 w.

5680. The New Bridge Over the Hudson River at New York (Illustrated description of the proposed New York and New Jersey Railroad bridge across the Hudson River). Sci Am–May 2. 1300 w.

5749. A Proposed Device for Weighing Stresses Caused by Moving Trains (The device described for the determination of the unknown quantities in bridge stresses consists of a series of hydraulic track supports, recording pressures automatically in connection with multiple instantaneous photographs showing the wheel positions of the passing train). Eng News–April 30. 600 w.

5750. La Rue's Formula for Curvature of Chords in Bridge Trusses (Letters from R. C. Berkeley, Jr., and Henry Szlapka, with reply from Benj. F. La Rue. Criticism and modification of Mr. La Rue's statements regarding tension in a vertical post under full load). Eng News–April 30. 900 w.

5754. Four-Track Swing Bridge over Harlem River, New York Central & Hudson River R. R. (Illustrated description of the general features only of the operating machinery. Drawings giving dimensions, material and details of construction). Eng News–April 30. 1000 w.

5909. The New Tennessee River Bridge at Knoxville, Tenn. (An illustration of the aesthetic element determining the choice of a bridge. The structure is of steel, arched cantilever design, for roadway and sidewalks). Eng News–May 7. 400 w.

Canals, Rivers and Harbors.

*5393. The Harbor Works at Tampico (From a paper read at a meeting of the Institution of Civil Engineers. This Mexican port, on the gulf coast, is interesting. Since the harbor improvements the trade has doubled in value, making it probably the second port in Mexico. Interesting also on account of the peculiar engineering difficulties). Trans–April 3. 1000 w.

*5552. Harbor Development in New Zealand (The Port of Wellington is the business center of the colony. A map is given of the berthage accommodations and the town, with description) Trans–April 10. 3000 w.

5564. The Proposal to Improve Mississippi River Navigation by Contract (Showing that the proposed private contract method would double the cost for the same amount of work done). Eng News. April 16. 900 w.

5628. Hydraulic Suction Dredge for the Navigation Improvements of the Mississippi River (An excellent description, with illustrations, of the same dredge reviewed in our Feb'y number). Eng News–April 23. 3000 w.

*5672. The Heinsrichsburg Canal Lift (Illustrated description of an interesting mechanism, designed to overcome a difference in elevation of 52½ ft. in the canal joining the Port of Emden with the Westphalian Coalfield. It is expected that it will be much more economical in working than those depending upon hydraulic presses for balancing power). Eng, Lond–April 17. 1300 w.

5747. Mr. Menocal's Reply to the Nicaragua Canal Commissioner's Report (In this reply, Civ. Eng. A. G. Menocal takes the ground that while the company regards and has treated the project as a business enterprise, with a view to commercial requirements, technical success, and financial results, the Bd. of U. S. Engineers ignores two of these conditions and considers the project from the point of unlimited expenditure, without any question as to financial results, and provides beyond commercial requirements for the present, for the accommodation of demands that, at the utmost, can only be claimed to be occasional. Both the board and the company are agreed as to the entire feasibility of the project. This reply has been submitted to the House Committee on Commerce. The editorial on this reply expresses the view that further surveys are advisable, and otherwise criticises Mr. Menocal's remarks). Eng News–April 30. 10500 w.

5751. The Evolution of Dredging Machinery. H. St. L. Coppée (A communication aiming to throw light on the subject of the cause of difference between the dredging machinery used in this country and in England). Eng News–April 30. 1500 w.

Hydraulics.

5386. Costs of Pipe Laying. G. S. W. (Abstracted from *The Technic*. Notes on nine cases from actual practice, giving conditions, dimensions, wages and other necessary data, with the cost of each item. In most cases old pipes had to be removed and expensive connections made). Eng Rec–April 11. 900 w.

5622. Efficiency of Nozzles for Small Water Motors. Arthur B. Ilsley and Herbert R. Thurston (Graduating thesis awarded first honorable mention in Engineering News Thesis Competition for 1895. The tabular statements of the experiments are briefly summarized in the table given, and the cuts represent a selection of the different forms of nozzles tested). Eng News–April 23. 1800 w.

5663. Hydraulic Rams. J. Richards (A study of the efficiency and defects of rams, giving experiments and illustrations). Eng & Min Jour–April 25. 2400 w.

Irrigation.

†5632. Irrigation in the North-West (From the report of the Irrigation Branch of the North-West Provinces, on the Great Ganges Canal, the Eastern Jumna Canal, the Agra Canal, the Bet-

wah Canal, with reports of progress). Ind & East Eng–March 28. 1600 w.

†5742. Irrigation in Siam (Account of the progress made by the Siamese in the art of irrigation, from which it appears that artificial irrigation is well advanced in Siam and its advantages fully appreciated. A description of some important irrigation works now in progress follows). Consular Repts–May. 1000 w.

Miscellany.

†5261. Slag Cement in Germany (Reports in answer to instructions from the Department of State, from the various consuls, with supplementary report describing the method of manufacturing slag cement). Consular Reports–Feb. 4000 w.

5329. Specifications for the State Highways of Massachusetts (Adopted by the Mass. Highway commission and includes specifications on earth work, rock excavation, rubble masonry, broken stone, telford gravel foundation, vitrified clay pipe, drains, finishing, gutters, etc). Eng News–April 9. 2200 w.

*5349. Famous Tunnels (A few particulars respecting some of the more famous tunnels in the world). Ill Car & Build–April 3. 1400 w.

*5397. Scientific Timber Testing. B. E. Fernow (By the chief of the Division of Forestry, in the United States Dept. of Agriculture. The paper deals with the considerations which are necessary for successful testing). Digest of Phys Tests–April. 3300 w.

*5398. Systematic Inspection of Material. L. S. Randolph (A general paper showing the tendency and importance of tests of material, such as is bought by the purchasing departments of railroads, and claiming that thus only can we avoid buying adulterated or imperfect material). Digest of Phys Tests–April. 1300 w.

*5401. Strength of Ice. C W. Beech, A. M. Munn, and H. E. Reeves (Extracts from *The Technograph*, No. 9. The device used to prevent unequal pressure on the faces of the ice cubes while crushing, is illustrated and the data is given in full for 55 specimens of ice tested, averaging 1451 lbs. per sq. in. compressive strength, and 19 slabs, averaging 718 lbs. per sq. in. The average tensile strength per sq. in. on 34 specimens was 165 lbs). Digest of Phys Tests–April. 2000 w.

*5442. Notes on Cement Testing. H. M. Morris (The first paper deals briefly with sampling, fineness, sand, mixing, moulding, setting, checking, boiling and tension tests). Ill Car & Build–April 10. 1800 w.

5528. A Hypothetical New Hydraulic Cement. A. D. Elbers (A scientific discussion of the essential properties in hydraulic cements and the effects upon the cement of hydration). Eng & Min Jour–April 18. 2200 w.

5563. The Manufacture and Use of Sand-Cement (Discussion of the qualities and tests of this new cement with illustrated description of works just put up at Long Is. City. One part of sand is ground with one part of cement in a cylindrical flint ball pulverizer making a cement which possesses great strength). Eng News–April 16. 1800 w.

5568. The Pennsylvania Avenue Subway and Tunnel in Philadelphia, Pa. (The engineering work involved in removing grade crossings is well illustrated and described. A bird's eye view with sections of overhead street crossings, tunnels, drains, profiles, etc., explain the construction fully). Eng News–April 16. 1600 w.

5623. The Claims of the Contractors for the New Croton Aqueduct (An interesting dispute between the contractors and the city, brought about by a change in design after the bids were made). Eng News–April 23. 1700 w.

*5636. Experiences in an Engineer's Practice. Walter V. Rice (Providing against settling in insecure foundations at the Petrie St. bridge, Cleveland, O). Jour Assn of Eng Soc–March. 2000 w.

5752. Effect of Magnesia on the Strength of Cements When Subjected to Freezing. Frank Haas and John Alexander McGraw (Thesis receiving second honorable mention in Eng. News Thesis Competition for 1895. Experiments made to find a means for counteracting the loss of strength from effects of low temperature). Eng News–April 30. 1000 w.

5755. Formulas for Long Columns (Letters from J. B. Johnson, and A. J. DuBois closing the discussion of the subject, and making an analysis of the points in dispute and of their positions concerning them). Eng News–April 30. 3800 w.

*5792. The Gohna Landslip and Flood (Means adopted by the government to prevent loss of life and property within range of the enormous volume of water that was expected to escape from the bursting of the dam formed in the river Birahi Gunga, one of the tributaries of the Ganges, by reason of a great landslip that blocked the stream in 1893. This is claimed to be the first authoritative account yet published). Eng, Lond–April 24. 4400 w.

*5799. Formulæ for Calculating the Perforation of Armor (Formula suggested by Captain Tresidder, of Brown's Armor Plate and Steel Works, which might, he urged, be adopted with advantage internationally on the following grounds: (1) Close agreement with actual results obtained at various velocities; (2) theoretical soundness; (3) simplicity. It is claimed that this formula gives results for high velocities which are much more nearly correct than the recognized British formulæ of Maitland or Fairbairn). Eng, Lond–April 24. 1800 w.

5913. Steel Rails for Common Roads (An editorial examination of this proposed innovation with a view to gain a clear idea of its possible merits and demerits. The conclusion is that the merits as contrasted with the demerits, do not warrant an actual trial in service. The subject is very ably treated). Eng News–May 7. 3200 w.

5932. A Topographic Map of Butte, Montana. R. H. Chapman (Showing the great economy of the plane-table and stadia method with reference to time, accuracy and actual cost where the scale is sufficiently large to warrant it). Eng & Min Jour–May 9. 650 w.

Coal and Gas for House Fires.

DR. J. B. COHEN and Mr. J. H. Russell have jointly been making an experimental investigation upon the combustion of coal and gas for house fires, and have presented the results in a well-written paper read before the Yorkshire (Eng.) Society of Chemical Industry. In this paper, printed in *Journal of Gas Lighting* (March 24), the authors explain that the objects of their experiments were to again determine the extent to which town air is polluted by the combustion of coal, and to ascertain whether a more extensive use of gas fires might be recommended by way of mitigating or removing the evil. The repetition of the experiments which the authors had previously performed was required by the discovery of sources of error in the methods then employed.

These sources of inaccuracy were, first, the hygroscopic property of the cotton-wool plugs by which the soot was collected, which, not being at first sufficiently appreciated, led to an excessive estimate of the soot, determined by weighing the chimney plugs before and after collecting the soot upon them. By thoroughly drying the plugs before weighing them, a more accurate determination of the quantity of soot collected has now been made.

A second source of error arose from periodic, instead of continuous, collections of the gases of combustion. By a system of continuous collection, a more accurate average of the amount of carbon dioxid carried out of the chimney has been obtained, and the results are presented in tabulated form for gas fuel and for coal.

"Using a similar kind of coal to that employed in the former determinations, the weight of soot per 100 litres of chimney gases and the percentage of carbon dioxid were both found to be much lower than on the previous occasions. The net result was to raise the percentage of soot on the carbon burnt from 5 to an average of 7.7 with this particular quality of coal. The average quantity of soot in twelve analyses, including eight of Yorkshire coals, two of Durham coals, and two of Wigan coals, amounted to 6½ per cent. on the carbon burnt. The quantity of soot obtained in different experiments with the same kind of coal varied, being no doubt influenced by the manner of firing and by the amount of draught. There was no slack in any of the samples."

The authors remark that "the use of gas in place of coal has often been suggested as a remedy for the smoke nuisance; and they allude to the fact that many people profess an objection to gas fires, either from experiencing a real feeling of discomfort, or from purely sentimental reasons. It has been alleged, moreover, that carbonic oxid is given off into the room from gas fires, — a statement which, if true, would manifestly condemn their use. They point out that it is impossible to ascertain or explain the cause of, and therefore to controvert, sentimental objections; but the other matters may be easily tested,—*i. e.*, as to the evolution of carbonic oxid, and as to the cause of physical discomfort. The authors had three different kinds of gas stoves placed at their disposal; and they were able to make a rough comparison between them and coal fires, as regards heating effect, from the point of view of economy and health."

The draught of a chimney is judged to play an important part in the heating of rooms by gas, and also with respect to the ventilation. It is further believed that gas can nowhere be used for heating at less than double the cost of coal; and in Leeds, where the experiments were performed, gas would cost three times as much as coal for the same heating effect.

"The authors think there is no doubt that a higher heating effect with coal may be attained in modern modifications of the coal-fire on the 'reflex' or 'lean-to' back principle, with small flue aperture; but they had no opportunity of testing this. In the case of a coal-fire the heating is mainly done by radiation; and the air of the room is only slowly warmed by contact with walls, ceiling, etc. With gas stoves, on the other hand, the air gets rapidly warmed. It is, therefore, necessary to guard against over-heating of the air by ascertaining the temperature from time to time and adjusting the gas; for air warmed above a certain temperature is apt to cause a feeling of dryness and discomfort. If the fireplace behind the gas-fire is closed so as to get the maximum heating effect, some opening into the chimney should be contrived by making an aperture at the ceiling-level. If the above conditions are observed, a gas-fire is a perfectly healthy heating appliance, more effective and more cleanly, although at the same time more costly, than coal. It must be remembered that these experiments on the comparative heating effects of gas and coal fires, although carried out with as much care as the circumstances allowed, do not pretend to absolute accuracy."

The amount of air drawn through the room for combustion of the gas (stated by the authors to be six times the volume of the gas burnt) seems too small; the amount is probably more nearly ten times the volume of the gas, and Mr. T. Fairly, chairman of the meeting at which the paper was read, stated that he had found this to be the amount.

Dangerous Enemies of Street Shade-Trees.

THE beauty of streets, as well as the comfort of urban dwellers, is admittedly enhanced by trees planted in the streets in the usual manner along the curbstones. The grateful shade in summer, and the partial obscuration of the long monotony of blocks of buildings fronting directly upon streets, are effects that would be much missed in many towns. Unfortunately, however, through the selection of trees ill adapted to this use, faults in planting, lack of proper care, and the attacks of natural enemies, the trees in a large number of American cities and villages are in a lamentable condition. *Garden and Forest* (April 8) has a good and timely editorial, discussing this subject very thoroughly.

Trees named as ill adapted to street planting are the short-lived sycamore maple, the weakly-constituted European ash, the brittle-limbed ash-leaved maple, and the poplars of all varieties "whose trunks are soon riddled by borers." The faults indicated as special in the trees thus named are generally to be avoided. Of trees not subject to these disabilities may be named live oaks and elms; but climatic conditions must influence selection, and probably there is no tree on the face of the earth that has not insect enemies. The soil, too, must be specially prepared, and must influence selection and treatment after planting, in order to obtain good results.

"There is no more excuse for planting a tree in imperfectly-prepared soil than there would be for sowing wheat on an unplowed field. If the young tree has abundant food for its roots and room for its branches to spread, and is properly anchored until it gets firmly set, it probably is left unmulched, and therefore exposed to drought and changes of temperature, or it has no guard against the teeth of horses, no opening in the asphalt about its base to receive water, or it is mangled by some ignorant tree-trimmer, and its wounds left bare to invite the rot fungus. The hopeless part of the case is that its natural protectors, the people about it, have no affectionate interest in it. They see it languish without any attempt to revive it. They do not consider one who wounds and bruises it a public malefactor.

"No doubt, the way to insure satisfactory street-trees is to put the whole business in the hands of a skilled commission. There is no reason why a man should be allowed to select the tree to plant along the street before his house, or to plant it in his own crude way, any more than he should be permitted to build his own sewer or his own sidewalk to suit his personal whims. Where there is a commission of men who understand their work, like those in Washington, every tree is inspected before it is planted, so that specimens of even growth and similar shape are secured. They are then scientifically planted and cared for; and, more than that, they are systematically pruned,—an operation which street-trees need above all others. Until the planting and care of these trees is considered an important municipal matter, like providing a water-supply, and one which as truly demands expert ability, the trees in our streets will be likely to excite commiseration rather than pride."

Public sentiment must be enlisted to secure reform in this matter. "One of the most serious dangers" now threatening urban trees is alleged to be the increased use of electricity. "No tree which stands on the public highway is out of danger from the axes of linemen." This statement is followed by a list of instances where noble trees have been thus ruthlessly sacrificed, and, although in some cases exemplary damages have been recovered, these cases are few, and have not served to check this sort of vandalism.

The natural enemies of trees are also increasing. Among these the gypsy moth, the elm leaf beetle, and other insect foes have been successfully routed by spraying; but spraying, to be effective, requires to be thoroughly and rapidly done, in order to get over all the trees at the time when it is useful. Hand-pumps are too slow, and a steam-driven spraying apparatus is suggested as a much-needed appliance. "Tree protector" leagues should be organized. As an example of such an organized effort the following is quoted.

"Last summer one of the Washington newspapers, in every issue through the summer, contained a coupon reciting briefly the desirability of protecting the shade-trees and enrolling every signer as a member of such a league, pledging him to do his best toward destroying the injurious insects upon the city's shade-trees adjoining his residence. If every household could be made to take a proper interest in this matter, the work would be half done. What is needed is intelligent work at the proper time,—the burning of the webs of the fall web-worm in May and June, the destruction of the larvæ of the elm-leaf beetle about the bases of the elm-trees in late June and July, the picking of the eggs of the tussock-moth in winter, and equally simple operations for other insects when they become especially injurious."

Ventilation of Gas-Heated Rooms.

THIS subject was treated in a paper read by Mr. Donald McDonald before the last meeting of the Ohio Gas-light Association, reported in the *American Gas-light Journal* (April 13). The author considered it not possible to devise a better means of ventilating a heated room than that "survival of the fittest," the open fireplace; but this method had to be modified when furnace heating came in, and again modified for steam heating and for hot water heating; and, now that gas heating has come in, it requires still further modification.

"Not only must we deal with the vitiation of the air by the inhabitants of the apartment, but we must also take into consideration the fact that the gas heater itself, in most cases, is putting out into the apartment large volumes of carbonic acid, water, and nitrogen,—sometimes less harmless gases,—and that it is continually taking from the air of the room the life-giving oxygen, leaving the air to this extent dead and uninvigorating. The products of combustion of any fire are neither more nor less than what the miners call 'after-damp.' That is the gas which fills the mine after an explosion has taken place. For want of any other short expression, I shall speak of these products in this paper by that name. All gas heaters may be divided into two classes. One class sends this 'after-damp' up the chimney, and the other puts all, or a part of it, out into the rooms."

Dealing further with the latter class—*viz.*, "stoves, radiators, and fires without any pretence of a flue," as being decidedly most numerous, the speaker said: "These are admissible in rooms which are used only occasionally, or which are opened very frequently; or, by providing abundant ventilation, a fairly good atmosphere may be maintained in any room with this class of heater. For bed-rooms, for sitting-rooms, or any other close room where the fire is burnt constantly and the windows kept closed, this class of heater cannot be condemned too strongly.

"Next comes the heater with the pretence of a flue; I say pretence, because most of the flues provided are totally incapable of carrying off more than a small fraction of the 'after-damp' and the air that mixes with it as soon as it is formed. I have seen a gas grate twenty-four inches wide provided with four ¾-inch round tubes to carry off all the products of combustion. The manufacturer had soothed his own conscience, and the purchaser, no doubt, congratulated himself on the good ventilation he would get; but, as a matter of fact, these tubes are able to carry off less than four per cent. of the 'after-damp' from this fire, and might just as well have been left out altogether.

"Another genus of this species of heater provides an ample flue with a damper to close it. The customer finds by experience that he gets very little heat when the damper is open, and consequently closes it tight and allows it to rust in that position.

"An open gas fire with a real flue (that is, a flue capable of carrying off all of the 'after-damp') is a class by itself, and can only be used in towns where natural gas is sold at a low price. It heats entirely by radiant heat, carries a large amount of air up the chimney, and is an excellent ventilator in every respect. It has only one draw back, and that is that, as it only utilizes about fifteen per cent. of the heat, its use is absolutely restricted to the fields where cheap natural gas can be obtained."

None of the objections attending the burning of gas in rooms without flues apply to gas burned in an ordinary furnace as a substitute for coal, and even the furnace without a flue is less objectionable than the first-named method, because, though it sends into the house all the products of combustion, it introduces a large volume of fresh air at the same time. A serious draw-back to this method is that, should the gas be extinguished, while continuing to flow, the unconsumed gas would flow directly into the apparatus connected with the furnace and thence into the house. This may happen, has happened in some instances, and is dangerous whenever it does occur.

"Heaters with real flues . . . . are rapidly finding favor with the public. With this class of heaters, having sufficient radiating surface, all the available heat except that required for draft can be utilized, and the ventilation can be made good by taking air from the floor and passing it through the fire." Mr. McDonald thinks it possible to utilize ninety-four per cent. of the available heat in this class of heaters.

Disinfecting Books.

Mr. Thos. Fletcher, F. C. S., in a letter to *Journal of Gas Lighting* (April 14), cautions the public against the use of gas-ovens for disinfecting books, as recommended by another correspondent; and declares that it is practically impossible thus to disinfect books without destroying them. He says: "Dry heat penetrates paper, woolen, and similar substances so very slowly that the minimum heat required—*i. e.*, 220° for at least four hours—is never attained, even in a very thin book, without the complete destruction of the outer part. The use of dry heat in gas-ovens has been so repeatedly proved to be useless for the disinfection of books, clothes, &c., that any attempt to reintroduce these appliances for such a purpose cannot be too severely condemned. This matter is fully dealt with in Whitelegge's 'Hygiene and Public Health'; and the total failure of gas-heated ovens for this purpose is well known to experts. A very simple experiment will show the difficulty. If a book is fastened so that the cover and leaves cannot curl open, and is then placed in the middle of a fierce fire, it will be found that the inner part is not even scorched after a long period; and the destruction of a pile of books by fire is a very difficult matter, even when they are turned over and raked, in order to expose fresh surfaces to the heat." He adds that the firm with which he is connected is frequently asked to make gas-ovens for disinfecting, but, knowing that such ovens will certainly fail of their purpose, orders for them are invariably declined.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Domestic Engineering in the American, English and British Colonial Magazines and Journals—See Introductory

Heating and Ventilation.

5290. Ventilation of Gas-Heated Rooms. Donald McDonald (An exhaustive paper considering the subject of gas-lighting and gas-heating in its sanitary as well as economic phases, followed by a protracted, spirited and instructive discussion). Am Gas Lgt Jour–April 13. 7400 w.

*5483. On Church Heating. H. B. Prather (By the combination of steam indirect and blowers. Illustrated detailed description of an elaborate system. A good article). Dom Engng–April. 2500 w.

*5498. The Combustion of Coal and Gas in House Fires. J. B. Cohen and G. H. Russell (Read before the Yorkshire Section of the Society of Chemical Industry. An exceedingly able and valuable discussion of the subject from both scientific and practical standpoints). Gas Wld–April 11. 3000 w.

5507. Economic Utilization of Exhaust Steam. William J. Baldwin (Extract from pamphlet on the Separation of Grease from Exhaust Steam. This paper answers the following questions. (1) How hot can feed water be made? (2) What percentage of the coal does the heating of the feed water represent? (3) How much of the exhaust steam from an engine can be used in heating the feed water necessary to supply the loss caused in the boiler by supplying steam to the same engine? (4) How much of it is left for use elsewhere, partly or wholly, to heat the building in winter or for drying purposes). Heat & Ven–April 15. 2000 w.

5508. The Carbonizing of Wooden Lagging on Steam Pipes (Report of inspector F. L. Pierce, of the Boston Manufacturers' Mutual Fire Insurance Co., with excellent engravings illustrating the carbonizing of wood lagging on steam pipes, thus rendering it liable to spontaneous combustion, or at least greatly increasing its combustibility). Heat & Ven–April 15. 1200 w.

5509. Study of the Heating and Ventilating Plants in the Suffolk County Court House, and the Massachusetts State House, Boston. Percy N. Kenway (Read before the Boston Society of Civil Engineers. Very full illustrated detailed description). Heat & Ven–April 15. 5600 w.

5510. Ventilation of Schools as Affected by Poor Sanitary Apparatus (Abstract from the report of the expert committee appointed by Mayor Quincy, of Boston, to examine into the sanitary condition of the school-houses in Boston). Heat & Ven–April 15. 2700 w.

*5560. Insulating Underground Steam Pipes. Edgar Kidwell (The methods described by R. C. Carpenter, in a previous issue, are criticised as examples of "how not to do it," after which the writer illustrates a method which seems to him more efficient. His method is substantially the use of a wooden box sheathed exteriorly with copper, and having a space to be filled with mineral wool surrounding the pipe, which latter rests on cast-iron supports). Eng, Loud–April 10. 900 w.

5761. Estimates of Radiation. Knight (A simple, concise and reliable method for most cases is given, whereby the extent of heating surface for rooms differently located may be computed). Met Work–May 2. 1800 w.

5838. Ventilation and Lighting of the Buffalo Real Estate Exchange (Illustrated detailed description of a radical departure from the usual method of constructing a modern office building. The indirect system of heating is used throughout, and every room in the eleven-story building is ventilated. The ventilation is forced by blowers). Eng Rec–May 2. 2800 w.

5899. Steam Heating Plants. Norman (Experiences with plants using exhaust steam from elevators). Sta Eng–May. 900 w.

5922. Heating and Ventilating a Brooklyn Church and Chapel (Illustrated detailed description of a church heated chiefly by indirect radiation, with some supplementary direct radiation, and in which the ventilation is effected, both winter and summer, by a fan blower driven by a gas engine). Eng Rec–May 9. 1100 w.

Landscape Gardening.

5352. The Plans of Madison Square (Letters from S. A. and L. G. S. discussing the plans published in this paper and offering suggestions). Gar & For–April 15. 600 w.

5675. Madison Square Again. H. A. Caparn (A letter, with proposed plan, and points of merit of the plan). Gar & For–April 29. 350 w.

Plumbing and Gas Fitting.

5481. Areas and Discharging Power of Pipes. J. L. Bixby, Jr. (Plumbing for different diameters. Table of discharging power with explanation, part of which is especially applicable to hot water work). Met Work–April 18. 700 w.

*5482. How to Plumb Our Houses—Theory and Practice. H. C. Patterson (What every property owner or intelligent citizen ought to know in order to decide for himself what are his necessities, and how to get them with least expense and annoyance). Dom Engng–April. 2200 w.

*5483. A Hotel Header (Description of hot and cold water supply to eleven baths and three toilets). Dom Engng–April. 200 w.

Miscellany.

*5288. Treatment of Wall Stains. A. Ashmun Kelly (Deals chiefly with processes and means for removing unsightly stains). Plumb & Dec–April 1. 1200 w.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading, and Domestic Engineering.

Vacuum-Tube Lighting Up to Date.

THE most interesting electrical paper of the current month is that read by Mr. D. McFarlan Moore before the meeting of the American Institute of Electrical Engineers (April 22) and printed in full in *The Electrical Engineer* (April 29). The paper—a very long one—was experimentally illustrated at the reading, and, as printed, is profusely illustrated by engravings. The importance of the subject, and its able treatment by the author, who has long been an ardent investigator in this field, demand more than an ordinary notice; yet we must despair of doing even small justice to it in the space that can be spared for it in this department. Much of it, however, if quoted, would be imperfectly comprehended, except by trained electricians, and these will doubtless peruse with care the whole of the paper. We can notice only a few points of more popular interest.

After an introduction indicating not only the possibility, but the near probability, of a system of lighting by vacuum tubes that shall rival sunshine, and possess the same qualities, the author says that "the new electric light should possess all the good qualities of the present lamp with none of its drawbacks," and that "among its improvements will be noted the combination of utility and decoration." The recognized tendency of the day is toward multiplication of lights and avoidance of strong shadows,—in other words, an even illumination, or light from all directions.

The object of the paper is to call attention not only to the advantages that will accrue with the adoption of vacuum-tube lighting, but more particularly to a simple method of obtaining a current which will ultimately make such an adoption feasible; and to this end the author describes "radical departures from well-beaten paths in principles, in apparatus, and in the nature of the current, resulting in a light of greatly-increased intensity." With this light the large hall in which the meeting was held was illuminated, greatly to the pleasure of the large and appreciative audience. The enormous difficulties which have obstructed the commercial success of the system were well portrayed. To surmount these difficulties, Mr. Moore has carried out a most carefully conducted and laborious series of experiments, the description and experimental illustration of which occupied three hours, and was listened to with profound interest. Not since Tesla performed his memorable series of experiments at Columbia College in 1891 has there been so remarkable a public display of experimental work in the electrical field. The author, in the introductory part of his paper, said:

"For many years the Geissler tube has been a scientific toy. When a suitable electric current is connected to its terminals, its entire length is filled with a faint glow. This is, of course, a light of radically different character from that now used in any commercial form of illumination.

"It is light emanating from rarefied air, with an apparent absence of heat and combustion. Upon this principle developed probably depends the light of the future, which will soon be, in the opinion of the writer, the 'light of the present.' As a device for transforming electrical energy into light, the vacuum tube is very efficient. The majority of authorities place it at about seventy per cent. and the incandescent lamp at two per cent. Notwithstanding this remarkable efficiency, it has never been commercially possible to illuminate by vacuum tubes, because the light could not be made sufficiently intense (this is expressing it mildly), even with bulky apparatus that was entirely impracticable.

"Furthermore, the current produced by such apparatus was of such a nature as to render its insulation extremely difficult. The ordinary induction coil is often used for this purpose. A current of low voltage, such as that from a battery of a few cells, must be used with such a coil, because a current of higher voltage could not be properly disrupted, the arc forming preventing a sudden break of the current. But, since the light depends on the suddenness of the break, the arc must be prevented; therefore the quicker the break, the brighter the light—provided the apparatus is properly designed.

"The quickest break can be made by interposing in a circuit the most perfect dielectric in the minimum space of time. The best dielectric known is a vacuum, and I have discovered methods for interposing it in rapid succession in a current in a minimum space of time, depending upon the principle of making and breaking a current rapidly in a vacuum.

"The disruption of any current in the air results in the formation of a spark of greater or less length, and the greater its length, the less sudden the break. Therefore, if the break be made in a vacuum, the narrowest conceivable complete gap in the metallic conductor results in an almost instantaneous discontinuance of current, insuring a maximum c. e. m. f. The current is thus interrupted in an almost infinitely short space of time as compared with all the ingenious mechanical contrivances, such as air-blasts and magnetic blow-outs devised for the purpose of breaking a current suddenly in the open air, but all of which are of little avail for the production of any quantity of light."

Having thus set forth the principle of the new system, the author next describes the vacuum vibrator which is "the nucleus" of his invention. It "consists merely of a spring rigidly supported at one end, and having attached to its free end a small disc of soft iron. A contact point rests against the spring at about its center. A sealed glass tube, from which the air is exhausted, incloses both spring and contact point. The system, as a whole, is exceedingly simple. An electric current passes through a coil of wire, and then through the vacuum vibrator. Wires in contact with the outside of each of the ends of a closed and empty glass tube are attached to the two ends of the coil of wire. This statement embodies the gist of the invention."

Attention is directed to the extreme simplicity of this device, as compared with means commonly employed for exciting luminosity in Geissler tubes. We pass over the technical part of the paper which follows, and quote the statement of some of the difficulties which have been encountered.

"Permit me to call your attention once more to the key of the whole system,—*viz.*, repeated interruptions of an electric current in a high vacuum.

"The simplest method of accomplishing this object is to hermetically seal within a glass tube a vibrator of ordinary form, but its exact construction, to give the best results, has been a matter of tedious experimentation and study. The very slightest alteration in the dimensions of almost any of its parts—such as the length, width, and thickness of the spring, or its method of mounting, or the position of the contact points, or the thickness or diameter of the armature—will cause it to be a very good or a very poor vibrator. Again, the operations of the glass-blower had to be watched most carefully. Only certain kinds of iron and steel were selected, to avoid occluded gases, and even then they must undergo a special treatment, before being fit for use. The selection of suitable contact points has also been a large field for research. Nearly all known conductors have been tried, and many interesting facts have developed in this connection, not only so far as the direct action on the various metals in vacua and various gases is concerned (and this in several instances is the reverse of the phenomena noted in open air), but also with reference to the electro-deposition or electrolytic action that takes place. For instance, as is well known, the positive electrode is the one which disintegrates most rapidly in the open air, and its apex is usually concave. This is probably best shown in the ordinary direct-current arc lamps. If aluminum, or any soft metal of comparatively low fusing point be used as contacts in a vibrator, after about a day's run, an examination shows that the shape and condition of the contacts are just the reverse of the way they appear after use in the open air. That is, the positive terminal looks like the negative, and the negative like the positive."

The speaker said he had constructed a large number of "varieties or amplifications of the ordinary type of vibrator, such as multiple contacts, etc.," and he described and illustrated some of these forms. He then entered upon the scientific theory of the unique properties of vacuum vibrators, which part of the paper we also pass, closing this review with a statement of some practical applications of this light which are anticipated.

"I may be pardoned for calling your attention to the remarkable intensity of the light in these tubes, in connection with the statements repeatedly made by eminent scientists that such intensity was an impossibility, and that efforts in this direction were comparable to those wasted on perpetual motion.

"The very nature of the light, if it is to be a counterpart of the ideal daylight, is such that, when a square inch of the surface of the tube emits as much light as that thrown into a room through an aperture one inch square, the want is satisfied. Then the desired illumination can be reached by multiplying the area and length of the tubes, and distributing them in the most advantageous manner,—that is, so that the light will fall from all directions. When a considerable area is to be lighted, the most efficient light is the one that is most equally distributed. However, there will always be a demand for units of light. Even this can be satisfied by using a tube of small caliber. This lamp is made by winding a small tube in the form of a spiral, its ends, to which the wires are attached, terminating in oblong bulbs three or four times the diameter of the small tube.

"I have previously stated that the alphabet has been constructed of tubes of light. Here are the initials of the body I have the honor to address, A. I. E. E., in letters twelve inches high. The delicate shades of these letters cannot fail to elicit admiration from all who love the beautiful.

"The principle of breaking a circuit in a vacuum has many applications to a variety of uses. Among them may be mentioned advertising signs, decorative electric lighting, electro-therapy, philosophical apparatus, theatrical effects, in the manufacture of ozone, in the kinetoscope, etc., etc.

"But the greatest field will ultimately be that of general illumination. You have noticed the tubes extending around this hall. Undoubtedly this is the first time that lighting by tubes has been attempted on so large a scale. You will note the almost entire absence of shadows."

Conductivity of Cement and Concrete.

LEAKAGE currents from the returns in electric tramways have always existed, and probably always will exist to some extent, no matter what effort may be put forth to prevent leakage. They are, however, less than they were in the infancy of electric-railway practice, and they will doubtless be still further reduced. In an abstract from a paper printed in *Elektrotechnische Zeitschrift* (March 19), *The Electrician* (April 10), quoting from the author, Dr. St. Lindeck, says that, of proposed remedies, "those should be preerred which attack the evil at its root,—that is to say, diminish the leakage from the rails, and consequently remove all disturbances at the same time." To this end effort to increase resistance "between rail and earth" is obviously in the line of progress, and Professor Ulbricht, in a prior contribution to the *Elektrotechnische Zeitschrift*, expressed the belief that, "even if we retain the return rail system, there are a number of ways of reducing the disturbances to a permissible amount." It is also obvious that a first step toward any exhaustive study of the problem is the determination of "electric conductivity of materials used for the foundation of electric tramlines."

Dr. Lindeck has therefore been experimentally investigating the conductivity of pure cement, concrete made of cement and sand, and concretes of cement and gravel in different proportions. He used parallelopiped blocks of cement, and of concrete. These blocks were 10 c m. × 10 c m. in section, and 40 c m. long; electrodes of perforated sheet iron with protruding ends were imbedded in the blocks. The resistance tests were made with a plug resistance box and a battery of ten small accumulator cells, the block to be tested completing the circuit. This description only indicates the general character of the method, and is not intended to cover all the details. The results are given in tabulated form, and the article itself must be consulted for these data. The results indicate, however, "that the electric resistance of cement blocks and blocks made of cement and sand or gravel when in an air-dry condition is relatively small; it is lowest of all in the case of pure cement, and becomes higher as more sand or gravel is mixed with the cement. The porosity of the material increases, however, in the same proportion, as can be seen by the decrease in the resistance after the blocks have been put under water for some time. In this way the resistances of cement blocks fall, after being under water for about one day, to one-third of the resistance shown when in an air-dry condition. In blocks containing one part cement and three parts sand, a two-hours' immersion is sufficient to bring the resistance down to one-tenth of the original. And in the two kinds of concrete the resistance of the blocks, when moist, drops to about one-twentieth.

"On the basis of these tests one cannot but come to the conclusion that the arrangement of the road-bed of electric lines must be very favorable to leakage, especially where the concrete on which the rails rest is covered with a layer of asphalt, which latter prevents a good drying of the concrete. The extent to which concrete retains moisture can be seen from the tests made on the blocks after they had been heated to over 100° C. for several hours. For instance, the resistance of a 1-decimeter length (1 decimeter square) of the compound, consisting of one part cement and seven parts gravel, rose to 6 or 7 megohms while in an air-dry condition, and three months after the manufacture the resistance was only 5,000 ohms. Similar results were obtained with the other concretes, but, after one month's exposure to air, the resistance fell to one-third of this figure.

"In the cement blocks the change of resistance due to heating was small compared with the compound blocks. The resistance rose at first to 1,000 ohms, and further, after one month, to about 2,000 ohms.

"If, for the purpose of an approximate calculation, the resistance of concrete in dry air is taken at about 5,000 ohms per 1 dm., sq. dm., a tramline put down on concrete would have a resistance to earth of under 1 ohm per kilometer.

"Prof. Ulbricht's communication directed attention also to asphalt-concrete, a material used to some extent for building purposes in Dresden. The same form and arrangements as for the other materials were adopted for this material, and the tests were made together with the others. Asphalt-concrete consists of 50 per cent. of stone chippings, 20 per cent. of rough gravel free from loam or sand, 12 per cent. of asphaltic mastic, 8 per cent. of pitch, and 10 per cent. of German tar. The composition of the material can, however, be varied as desired.

"It would be of little use to record here all the tests of the different blocks, as there was always an extremely high resistance, and one could never be sure whether one was dealing with the conductivity of the material, or only with surface conduction. For instance, a block made with 'Syenit' chippings gave in dry condition per 1 dm., sq. dm., 280,000 megohms. The block was then placed under water for 2 hours, and, after having been again in the air for 2½ hours, it still showed a resistance of 160,000 megohms. Even after the block had been continually under water for 6 weeks, it still gave an insulation resistance of 17,000 megohms. Similar results were obtained with other blocks of asphalt-concrete. The material is, therefore, practically waterproof."

Summing up, it appears most probable that, by using asphalt-concrete, the rails could be permanently insulated from earth to such an extent that leakage currents of any importance could not occur. The asphalt-concrete should be laid in a thin layer over the cement-concrete, so that the cost of a line would not be appreciably increased.

Arc-Lighting Practice.

One of the best practical electrical papers printed during the current month is an article contributed to *Electrical Engineering* (April) by Mr. Alex. Dow. It is a general review of arc-lighting practice in America, with brief reference to an excellent paper by Mr. John Hesketh (*Electrical Engineering*, Feb.).

As Mr. Dow is the electric engineer of the public lighting commission, Detroit, he is in a position to speak authoritatively.

As regards carbons he states that only recently, and coincidently with "the introduction of arcs on constant potential systems," the use of "imported carbons, with cores of differing diameters, began"; and he asserts that "the alternating arc was a rank failure until a proper carbon and 30- or 33-volt adjustments were adopted." In this and in other respects practice in arc lighting has much improved.

"The ½-inch coppered carbon still holds the field in street lighting, and is likely to hold it for some time to come. The practice of using partly-burned uppers in the lower holders, and double carbon lamps for all-night street lighting, are the factors of greatest importance in deciding this, because they require the purchase of but one size of carbon (usually 12 inches long, but ½ inch diameter), and yet allow of every piece of carbon being fairly burned out,—the short lengths produced at one season being mated and reissued to the trimmers at another. The worst fault of the ½-inch carbon plan is the 'lapping' of points during the run,—that is to say, the dropping of the upper carbon past the point of the lower, causing a short arc or total extinction. If the current is a trifle high, so that the conical points are longer than normal, or if the carbons are a little crooked, this trouble may become serious. Lamps on towers, or other supports much affected by wind or vibration, are specially liable to it."

In the plant operated by Mr. Dow, "an analysis of the 'outs' for two months showed that lapping was responsible for too much of the total trouble. We were running with $\frac{7}{16}$-inch (11 mm.) carbons in both holders, and a large number of lamps were in towers, while still another large number were on poles to which electric street-railway span wires were attached. We changed to ⅝-inch (16 mm.) uppers, retaining the $\frac{7}{16}$-inch lowers. Result for four winter months' operation of 1,480 street arcs is just one 'out' by lapping. We cannot see any practical difference in the total light. Experiments show a little difference, but it is negligible in comparison with the improved reliability."

For interior lighting the uniform carbon has permanently gone out of use. On this point Mr. Dow says: "I have only a dozen interior lamps—the incidents of a plant installed primarily for street work; but these dozen use three different carbons,—to wit: 13 mm. American-made cored uppers with 13 mm. American solid lowers, forced, and not coppered, these being pairs for 45 volts by 9.6 amperes direct-current arcs, and 13 mm. 'Electra' cored, for alternating 30 volts by 15 amperes arcs. It is not unusual nowadays to find a station carrying in stock ten different carbons for interior work; and the use of uppers of larger diameter than the lowers is frequent, though not yet general. I fear that the refinements found in the best European carbon practice will (like the best of the European arc lamps) never acquire a permanent footing here. The effort to systematize, which has reduced constant current series arcs throughout the

United States to two standard currents, 9.6 and 6.8 amperes, will reduce carbons to a very few sizes and styles. To our central-station men life is too short to fuss with lamps of the delicacy of chronometers and with carbons of different sizes for each month in the year.

"I notice, however, the differentiation of the street-lighting lamp from that rented to private patrons. It is not long, say three years, since the total difference was in the style of the jacket; the street-lamp jacket was japanned iron, while the private customer's lamp was done up in brass. Now the difference is radical. I have already noted it in carbons. In mechanism the private lamp (if I may so call it) is frequently a shunt wound lamp, if run on a series circuit, and often it has a rack feed. The public lamp is usually differentially wound, and almost always has a clutch feed. The difference in mechanism extends even to the adjustment of individual lamps, the station lampman cultivating a feed by imperceptible movements for the private lamp, which the said lampman calls a 'sneak' feed, while on the public lamp he adjusts for a 'drop' feed,—that is to say, he tries to have the clutch kick itself entirely clear of the rod at the instant of feeding, causing a *drop* rather than a *slide* of the upper carbon, and the regulating magnet is relied on to immediately adjust the arc to the proper length when the clutch gets its new hold."

The reasons given for this differentiation and the remarks upon the pronounced differentiation of the outward appearance of the public and the private lamp are interesting, and the prediction with which the author dismisses the subject of lamps —to wit, that arcs maintained in an inert atmosphere will be the feature of private lighting for the next-year seems entirely justified by recent progress in this line. He also thinks that the rectifier will soon be introduced in American practice, and hopes that its usefulness will be extended from the 60-light machine to larger sizes,—naming 100-light and 125-light as probable sizes. He bases this opinion upon the experience of Mr. Hesketh, with a 60-light Ferranti rectifier, wherein 73 per cent. efficiency was attained, and states that he gets identically the same efficiency; and he adds: "I do not question that the rectifier is more efficient than a 55-light Brush set."

The necessity for 100- or 120-light series circuits exists in American street lighting, and 5,000 or 6,000 volts may be used advantageously in transmission, "even at some sacrifice of station efficiency, and even when coal is but $2.25 per ton of 2,000 pounds.

"The economy of never running an underloaded engine can only be secured by the use of smaller engines, in place of large, which latter, no matter how refined in their construction, can not be used economically, when not running at or near full load. If the arc-lighting engineer will understand that his extra boiler capacity had better be standing idle, but ready to fire on a moment's notice, and that his big cylinders had better be traded for others of half the piston area to fit the same engine-bed and shaft, he will have learned the first and greatest rule of central station economy." It might be added that this lesson needs to be learned in many central stations.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Applied Electricity in the American, English and British Colonial Electrical, and Engineering Journals—See Introductory.

Lighting

*5265. Development of Electric Lighting Engines. H. Lindley (Showing the considerations and improvements that have led to the substitution of engines of moderate and high speed for those of slow speed, in electric lighting work). Eng Mag–May. 2800 w.

5283. The Incandescent Lamp. George White Fraser (A review of the history of the invention, with an account of tests, and drawing conclusions that will suggest the proper way to purchase and the proper way to run them). Can Elec News–April. Serial. 1st part. 2400 w.

5284. Railroad Station Lighting Plant at Syracuse, N. Y. (Illustrated description). W Elec–April 11. 500 w.

*5348. Public Lighting by Arc Lamps. André Blondel (The writer purposes making a close examination of the means actually employed in the production and utilization of this source of light, indicating possible improvements). Elect'n–April 3. Serial. 1st part. 2400 w.

5363. Arc Lighting Practice. Alex Dow (Some reference to comments of Mr. John Hesketh on arc lighting practice in England, with other matter of interest on the subject). Elec Engng–April. 3400 w.

*5371. Systems of Wiring. Joseph T. Monell (Lecture delivered before the Henry Elec. Club. Considers the various systems and their advantages and disadvantages). Elec Pow–April. 2300 w.

5432. Some Advantages of Electric Light. George D. Shepardson (A paper read before the Minnesota Chapter of the American Inst. of Architects. The various methods of using the electric light both for illumination and illumination appearance are dwelt upon and the advantages stated). Imp Bul–April 17. 1600 w.

5494. The New Three-Phase Electric Lighting System of Salt Lake City (Illustrated description). Elec Eng–April 22. 1800 w.

5511. Electricity in Horticulture. Ill. (Abstract of a report made by L. H. Bailey on the experiments carried on at Cornell University with a view of determining the influence of electricity in horticulture). W Elec–April 25. 1800 w.

*5539. New Electricity Works at Islington (Descriptive. The principal feature is the provision that has been made for easy extension and increase in capacity of the station without any inconvenience or interruption to the supply). Elec Plant–April. 5000 w.

5676. Recent Developments in Vacuum Tube Lighting. D. McFarlan Moore (Paper read at the meeting of the Am. Inst. Elec. Engrs. The object of the paper is not only to call attention to the advantages that will accrue with the adoption of vacuum tube lighting, but more particularly to a simple method of obtaining a current which will ultimately make such an adoption universally feasible). Elec Eng–April 29. 8300 w.

*5794. Experiments with Accumulators for Lighting Railway Carriages. G. Klose (Examinations of systems of accumulators made in a series of experiments carried out by the Hungarian State Railways during the past year, on the lighting of railway carriages by electricity). Eng, Lond–April 24. 600 w.

5865. The New 28th Street Station of the United Electric Light and Power Co., New York (Describes and illustrates the building, boilers, engines, dynamos, exciters, feed pumps, electric crane, coal and ash conveyor, piping, switchboard and switch gallery). Elec Eng–May 6. 3400 w.

5868. An Instrument for Directly Measuring the Mean Spherical Candle-Power of Arc Lamps or Other Luminous Sources. Edwin J. Houston and A. E. Kennelly (Description of an apparatus capable of giving direct measurements of the mean spherical candle-power of a luminous source. By the use of this instrument it becomes possible to measure at one observation the total quantity of light emitted by an arc lamp at any given electric activity). Elec Wld–May 9. 1500 w.

5869. The History of Electric Lighting. Francis B. Crocker (Review of the subject from its earliest beginnings to the present, showing progress. The three most prominent systems are briefly explained, and the possibilities of improvement considered). Elec Wld–May 9. 3700 w.

5912. Report on Municipal Ownership of Electric Street Lighting Plant for Utica, N. Y. (The committee of the Common Council after quite a discussion and reviewing the experience of other cities, concludes that the service can be secured quite as cheaply by private contract. But the appointed electrical engineer in his report, strongly recommends municipal ownership). Eng News–May 7. 900 w.

Power.

*5267. Electricity and the Horseless-Carriage Problem. Wm. Baxter, Jr. (Comparing steam, oil, gas, and electricity as motive powers for automobiles, and maintaining the superiority of the electric storage battery for this purpose). Eng Mag–May. 3300 w.

5285. Electrical Station Economy. Dr. Rasch, in *L'Industrie Electrique* (Showing that the capital invested in electric lighting alone is not properly utilized. Discussing the charges for power and light, and the arrangements made in effort to overcome injustice and difficulties). W Elec–April 11. 1500 w.

*5293. The Westinghouse Electrical Works (Illustrated description). Engng–April 3. Serial. 1st part. 1800 w.

5361. Electricity and Water Power. Mark A. Replogle (The writer aims to put into plain language the fundamental principles by which electrical phenomena are explained). Elec Rev–April 15. Serial. 1st part. 1700 w.

*5372. Systems of Dynamo Regulation. Joseph Sachs (Edited by W. H. Freedman from the stenographer's notes of a lecture delivered before the Henry Electrical Club. A consideration of the various methods and their modifications). Elec Pow–April. 2000 w.

5381. Niagara Model for the Electrical Exposition. Orrin E. Dunlap (Illustrated description of a beautiful model of Niagara in miniature, to be exhibited at the forthcoming electrical exposition to be held in New York). W Elec–April 18. 1400 w.

5383. Model Factory Electrically Operated (An illustrated description of the power plant of the Northern Electrical Manufacturing Co., at Madison, Wis.). W Elec–April 18. 700 w.

5384. Transmission of Power in Factories. J. J. Flather (A consideration of the subject favoring the driving of machines by means of electric motors). W Elec–April 18. 1300 w.

5491. Electric Power in Brick Yard and Foundry. F. M. Tait (Illustrated description of the power plant lately installed in the works of the Lehigh Fire Brick Co., of Catasauqua, Pa., with brief mention of plant installed at the works of the Davies & Thomas Co., East Catasauqua, Pa). Elec Eng–April 22. 800 w.

5492. The Trenton Falls and Prospect Water Power Development. Orrin E. Dunlap (Description of the locality with account of its power possibilities as given in the report of Mr. Wallace C. Johnson. General plan of development, etc). Elec Eng–April 22. 1600 w.

5493. California Water Power in Electrical Harness. H. G. T. (Abstract from correspondence in the *N. Y. Evening Post.* Brief review of the work already done and in prospect in this line). Elec Eng–April 22. 1800 w.

*5538. The Generation and Distribution of Current by an Edison Station. J. W. Lieb, Jr. (Paper read before the N. Y. Electrical Society. Reprinted from *Electricity, N. Y.* Historical account of the development of the company and description of station, &c). Elec Plant–April. 4500 w.

*5570. Experiments Upon Friction in Electric Motors and Transmission Shafting (Review of article published in the Inst. Civ. Engs. Foreign Abstracts, giving an account of experiments made in electric motors and transmission shafting in the electro-mechanical laboratory of the Ecole Spéciale d'Industrie et des Mines, at Hainaut. The methods followed, with a view of determining between what limits the power absorbed by subterranean transmission shafting varies, are capable of general application). Mech Wld-April 17. 800 w.

*5586. The Rhône Hydro-Electric Installation (Illustrated description of an undertaking on a large and very comprehensive scale, the object of which is to convert the water power of the Rhone into electric energy, to be distributed throughout the city of Lyons, and adjacent districts). Engng–April 17. 3500 w.

5656. The Operation of Compound Wound Generators in Parallel. J. E. Woodbridge (A study of the action of a plain shunt-wound machine and a simple series wound machine, the compound-wound dynamo being a combination of the two). Elec Ry Gaz-April 25. 2000 w.

5657. The Elementary Principles of the Rheostat, Commutated Field and Series-Parallel Methods of Controlling Railway Motors. William Baxter, Jr. (The general principles will be explained in these articles, and the way in which they are applied by several of the leading manufacturers will be illustrated and described by the aid of the wiring plans they furnish). Elec Ry Gaz–April 25. Serial. 1st part. 2000 w.

5660. Electrically Operated Bicycle Works (Illustrated description of the Miami Cycle & Mfg. Co. of Middletown, O. In addition to the load at the works the generator supplies current to lights throughout the town). Ir Tr Rev–April 23. 800 w.

5686. Electric Propulsion by Subterranean Conductors. From *La Nature* (Notes on the different systems of subterranean conductors in conduits for electric propulsion, with illustrations of some of the most important). Sci Am Sup-May 2. 1500 w.

5722. The Twenty-Eighth Street New York Station of the United Electric Light and Power Company (Illustrated description). Power–May. 3000 w.

5723. Generators Run as Motors. William Baxter, Jr. (The cause of fly-wheel accidents in electric stations). Power–May. 3400 w.

5816. Electric Power for Mines and Iron Works. Carl Pfankuch (Read at a recent meeting of the German Ironmasters' Association. Abstract giving the writer's idea of the saving that could be obtained by the adoption of electricity as motive power, and where it could be most advantageously applied). Am Mfr & Ir Wld-May 1. 1100 w.

5846. Electrical and Mechanical Equipment of the Milwaukee City Hall (Illustrated description of a very completely equipped building). W Elec–May 2. 2000 w.

5866. The Electrical Plant in the Siegel-Cooper Co.'s "Big Store," New York City (Illustrated description. Electricity is utilized for light, heat, power, ventilation and as a means of attraction). Elec Eng–May 6. 3800 w.

5870 Little Economies in Central Station Practice. Thomas G. Grier. Read before the Chicago Electrical Association (A compilation of points suggested by correspondence with a number of central station men). Elec Rev–May 6. Serial. 1st part. 1400 w.

†5890. Distribution of Electrical Energy from a Central Station. Ill. William C. L. Eglin (Dealing with the distribution of electrical energy in large cities using underground conductors with a continuous supply—twenty-four hours per day, and seven days per week. The energy to be supplied in such a form as to meet all the commercially practical uses to which electrical energy may be put). Pro Eng's Club of Phila–April. 4000 w.

5895. A Series-Motor Controller and Reversing Switch (Illustrated description of a controller designed with particular reference to the requirements of the traveling cranes of the Morgan Engineering Co., of Alliance, O., and produced by them). Am Mach–May 7. 1100 w.

5896. Torque and Counter-Torque, Electromotive Force and Counter-Electromotive Force (The terms given in title are explained, and examples of their action given). Am Mach–May 7. 600 w.

5911. The Folsom-Sacramento Electric Power Transmission Plant (Illustrated account of the electric plant in detail). Eng News–May 7. 1100 w.

Telephony and Telegraphy.

*5345. Colonial Cable Communication and the Projected Pacific Cable (A discussion of this important subject. The first part is mostly a review of what has already been done toward finding best route, &c). Elec Rev, Lond–April 3. Serial. 1st part. 5000 w.

5365. Telephone Service—Its Proper Use. Fred DeLand (The relation of the telephone to business is the theme). Elec Engng–April. 1000 w.

*5433. A New French Trans-Atlantic Cable (From *L'Electricien.* The text of the report made by Mr. Boudenvot, in the name of the Budget Commission. Considering the establishment of direct and reliable communication between France, the United States, and the West Indies). Elec Rev, Lond–April 10. Serial. 1st part. 1800 w.

*5434. Concentric Cables (A brief letter of inquiry from P. S. Clay calls forth an Editorial reply of some length on a point in connection with concentric cables). Elec Rev, Lond–April 10. 1400 w.

*5436. International Telegraph Conference of 1896 (Suggestions to the delegates to the meeting to be held at Buda-Pesth on June 16, favoring centralization of management). Elec Rev, Lond–April 10. 1200 w.

*5541. The Development of the Telephone System (Editorial discussing the attitude of the government to the telephone interests in England). Ind & Ir–April 10. 1500 w.

*5646. Safety Devices for Telephone Circuits. F. Mertsching (Abstract from the *Elektrotechnische Zeitschrift.* An account of some instructive experiments made in Germany, with a device for putting broken telephone wires, when they break in the vicinity of trolley lines, immediately into good contact with the earth). Elect'n–April 17. 900 w.

*5648. Gear for Japanese Submarine Cable Steamer (Illustrated description of a combined picking up and paying out gear, for the new submarine cable laying vessel of the Japanese government). Elec Rev, Lond–April 17. 900 w.

*5796. Combined Cabling and Serving Machine (Illustrated description of a machine for cabling gutta-percha covered cables, and at the same time serving them with compounded tape. The machine is arranged for cabling seven wires, —*i. e.*, laying six wires around one, and at the same time laying a yarn in the recess formed between each pair of wires, so that when the cable is taped it forms a more perfect round). Eng, Lond–April 24. 400 w.

*5856. Telephony and Telegraphy. N. Amzan in *L'Eclairage Electrique* (Discussing the possibility of utilizing the secondary telegraph lines for telephonic conversations. The first part considers alternate telegraphic and telephonic communications, and simultaneous telegraphic and telephonic communications). Elec Rev, Lond–April 24. Serial. 1st part. 2000 w.

Miscellany.

*5346. Recent Experiments with the Globular Discharge (The first part is descriptive of experiments for investigating by artificial production this peculiar phenomenon). Elec Rev, Lond–April 3. Serial. 1st part. 3000 w.

*5347. The Graphic Representation of Vector Potential. H. N. Allen (The object of the paper is to show how the distribution of electromagnetic vector potential can in certain cases be represented graphically). Elect'n–April 3. 900 w.

*5370. The Electric Cell. Ill. W. P. Jones (A brief glance into this field, dwelling on the points the writer has been most frequently asked to make clear). Elec Pow–April. 1000 w.

*5438. Experiments on the Hall Phenomenon in Bismuth. Dr. A. Lebret (Investigations made at the physical laboratory of Leyden under Prof. Kamerlingh Onnes' guidance). Elect'n–April 10. 2400 w.

*5439. On the Electric Conductivity of Cement and Concrete. Dr. St. Lindeck (Abstract from the *Elektrotechnische Zeitschrift.* Communication from the Reichsanstalt. The writer thinks it appears most probable that by using asphalt concrete the rails could be permanently insulated from earth to such an extent that leakage currents of any importance could not occur). Elect'n–April 10. 1000 w.

*5440. A Method of Measuring the Loss of Energy in Hysteresis. G. F. Searle (Paper read before the Cambridge Philosophical Society. A method for determining the hysteresis loss by a single observation of the "throw" of a spot of light along a scale). Elect'n–April 10. 1200 w.

5475. Advantages of Grooved Armatures. William Baxter, Jr. (The main point of superiority of the grooved armature is that it provides a perfectly rigid support for the wire. Other advantages are also shown). Am Mach–April 16. 2300 w.

5514. How to Use a Voltmeter as an Ammeter. George T. Hanchett (Illustrated description). Elec Wld–April 25. 1800 w.

5569. Electricity Direct from Carbon. C. J. Reed (An article written in refutation of the ideas set forth in a recent paper by Dr. Alfred Coehn. The writer claims that he did not prove electricity could be obtained direct from carbon, but rather that carbon was obtained from electricity, and points out errors). Elec Wld–April 25. 900 w.

5691. Mechanical and Electrical Work and Power (A discussion of the agreement between mechanical and electrical power). Am Mach–April 30. 1500 w.

*5730. Blasting in Pole Line Construction. I. J. Macomber (Description of a piece of work in charge of the writer, where nearly half the distance required rock blasting in setting the poles, showing the necessity of carefully examining the route of a proposed pole line, before making a final estimate of cost). Sib Jour of Engng–April. 1500 w.

5745. Fourth Annual Report of the General Electric Company (Reports of Pres. C. A. Coffin, 1st Vice Pres. Eugene Griffin, and 3d Vice Pres. E. W. Rice, Jr., with editorial). Elec Wld–May 2. 2800 w.

5753. The Steam Plant of the National Electrical Exposition (A brief illustrated description of a plant especially designed by a committee appointed for the purpose, to be a strictly modern plant, containing only the latest appliances). Eng News–April 30. 900 w.

5871. On Determination of Grounds on Alternating Current Circuits. R. O. Heinrich (The use of an electrostatic voltmeter for this purpose is explained, also the direct reading voltmeters of the electro-dynamometer type, such as the Weston, and the advantages of the latter are shown. A numerical example is given to illustrate the operation). Elec–May 6. 2000 w.

INDUSTRIAL SOCIOLOGY

Is Underselling a Crime?

THE affirmative of this question is supported by Mr. E. J. Smith in *Machinery* (London, April 15), in an article entitled "A New Remedy for an Old Evil." Mr. Smith is the head of the Bedstead-Makers' Association, a notable organization based on the following simple propositions.

"There is only one honest way of doing business,—to make the best article you can for the money, and make some profit out of the transaction. You have no right either to cheat your customer, or ruin your competitor by selling goods at less than it costs you to produce them. We are told that capital has a right to run risks, and sell for awhile at a loss, in order to make a connection,—that is, that rich men have a right to take away the customers of poorer and honester men by beginning to sell at prices which they cannot continue. Capital has no right to do anything of the kind; and, if the laws of the country will not prevent it, common sense and good organization must. If honorable-minded employers cannot prevent it among themselves, they must call in the services of their work-people, and pay them for the help they give. There is justice as well as reason in this course. Both sides have suffered by the practices of the past; both sides must help to remove the evil; both sides must benefit from the result."

In an address recently delivered by Right Honorable J. Chamberlain, the British colonial secretary, he spoke of this movement as follows:

"I don't know whether you are aware that within the last year or two he [Mr. Smith] has carried out in connection with the trade with which he is connected a great social experiment, the results of which have been truly marvellous. In a trade in which, formerly, every one, whether workman or employer, was dissatisfied, he has brought contentment. Wages, I believe, have been increased, profits have become larger, and, curious to relate, the demand and the production have also increased at the same time. This experiment, I believe, is capable of great development. I understood, when I was last in Bradford, that a great trade in that city, acting on Mr. Smith's suggestion, has agreed to adopt the principles upon which he has secured success. Those principles involve a hearty union between employers and employed; and I trust that all who find themselves in a difficulty will, at all events, give some consideration to the solution which Mr. Smith believes that he has found. I am always glad that a new light should proceed from Birmingham and, if Mr. Smith is successful in dealing—as I think he may be—with many of the most urgent of our social problems, he will have gained from us an additional claim to our gratitude and our respect."

In an editorial calling attention to the movement and also to Mr. Smith's article, *Machinery* says:

"This gentleman claims to have solved one of the greatest social and economic problems of the day,—that of making a profit in business and insuring labor its share in it. All new movements of this kind arouse hostility. The political economist distrusts them. Trade rivals denounce them. The public looks on with practical indifference, tempered with a belief, carefully instilled by the enemies of the movement, that restriction and higher wages mean ultimately higher prices to the consumer. In spite, however, of all the obstacles which we have mentioned, and the *vis inertiæ*,—that inert opposition which ignorance and prejudice invariably offer to any innovation in the ordinary relations of labor and capital,—Mr. Smith's ideas have fructified; they have taken definite form; they have been tested; they have, it is claimed, succeeded. In fact, the claim is established and vouched for by the fact that numerous bodies and manufacturers have formed associations on the lines laid down by the chairman of the bedstead makers' organization."

The details of the operations of the Bedstead-Makers' Association are promised for a future number. The article under review is confined to the main question: is underselling a crime? At the present time both in England and America it is not legally a crime, but Mr. Smith holds that it should be made legally criminal, being in his opinion morally culpable. Reduction of profits means always an ultimate reduction of wages. It also means deterioration of product, and both these are public evils. Mr. Smith says:

"That the underseller is not a criminal legally, at present, is a matter to be deplored, but that he is so morally seems beyond question. It is true that it is possible for some traders to do a large amount of underselling, and still continue to pay their creditors twenty shillings in the pound. It is also true that fortunes have even been made by some special kind of underselling. It is, however, impossible to judge of the morality of an action from the measure of its success in special instances. Success to one individual frequently means ruin to many others. There must be a principle upon which trading should be carried on, and that principle cannot be to sell articles at the same price, or less, than the cost of production. That inventive genius may originate better methods and improve processes of manufacture, which, by cheapening the cost of production, will very properly turn the current of some trade into one particular direction, is a matter of course; but this is not underselling in the criminal sense. Ingenuity and enterprise in business must be followed and imitated, or the stupid or sluggish must suffer. Moreover, every opportunity must be given to industry and ability in business, and any scheme which aims at fettering—or limiting—either cannot be universally adopted, or be successful for long. But every business man must know that these are not the causes of the underselling which ruins manufacturers, and drags even the skilled workmen down to starvation wages. This kind of underselling arises from two causes only,—ignorance and recklessness. Possibly both are not equally criminal; but both are criminal, nevertheless. Any trader having to meet his creditors from either of these two causes, and not being able to satisfy these creditors' lawful claims, is a dishonest trader, and should be recognized as such by the laws of the country. The time will yet come when we shall follow the example of some other countries, and make this a criminal offence. It must be remembered that the effects of this criminal underselling do not stop with the underseller,—or even with his creditors. He has probably succeeded in dragging down a trade to his own level. He has prevented honest men from gaining an honest living. He has flooded the market with an article for which, after all, there can only be a certain demand, and has injured—perhaps ruined—the competitors who wish to do a legitimate trade. Also, unfortunately, the meeting with his creditors seldom ends his dishonest career. A composition is generally accepted, and he is permitted to continue for a further period a course which leaves ruin and misery in its train. It is a scandal and a disgrace that such persons should be permitted to harass legitimate trading in a country which enjoys its great freedom because of its restriction of unwarranted license."

We are sorry that Mr. Smith's present article does not present material for a full outline of the working of the association; but, as he has promised this in a future article, we shall hope to give such an outline in a subsequent review.

Eastward "The Star of Empire Takes Its Way."

THE world has awakened to the fact that, with the shaking off of the fetters of ages in Japan, a new era has dawned for the entire Mongolian race. Japan is to the neighboring Mongolian States what Britain in the sixteenth century was to Ireland and Scotland, and the influence of her advancing civilization and her progress toward free institutions will be found as irresistible in China and Corea as that of Britain was upon the barbaric tribes of Ireland and the Highland clans of Scotland. The present generation has witnessed the dawn of a great oriental civilization. Statesmen, economists, historians, and politicians are viewing this wonderful movement with almost breathless interest. The rapidity and force of the Japanese advance are unparalleled in the history of the world.

The way in which this movement is regarded in England, the birth-place of free government, is easily gathered from editorials, speeches, and board-of-trade reports. Whatever faults are peculiarly English, blindness to the interest of her great commerce cannot be numbered among them; and it is evident from the tone of discussion upon oriental progress that the British government keeps a most alert watch on the progress which the Japanese are making in the arts both of war and of peace.

Under the title "Industrial Problems in the Far East," *Engineering* (April 3) says:

"The rapid changes and the solid progress made by Japan during the past quarter of a century are unique in the history of the world, and afford a most instructive lesson as to what a nation can do when it makes up its mind not to drift along in an aimless manner, but to work out its own destiny in its own way and according to its own ideas. Nothing has been more remarkable than the growth of an intelligent public opinion in Japan, as is evidenced by the great and rapid development of the newspaper press. A quarter of a century ago newspapers were practically unknown in the country; now there are hundreds of them, which are eagerly read by all classes of the community. During the recent war the patriotic feeling which was evolved was most intense, and the nation rose in a body to support the action of the government. The spirit which animated the army and the navy partook almost of the nature of that of the crusaders, and became religious faith which impelled them to deeds of daring and endurance. When this was backed up by effective organization and equipment, the Chinese, who were badly armed and led, and were wanting in patriotism, found them irresistible. While those who knew the Japanese were prepared for brilliant feats of arms on their part, they did not expect such an utter collapse on the part of the Chinese,—a result which has proved that the government of the country is in an entirely demoralized condition. Should the war prove to have been the means of arousing the national spirit of China, it will be impossible to estimate the ultimate results. When hostilities broke out, it was evident that public opinion in England was in favor of China, and Japan was looked upon as a wanton aggressor; but, as the *Times's* special correspondent recently pointed out, facts have been disclosed which prove that China has for some years contemplated the invasion of Japan, and that the preparations for it were intrusted to Li Hung Chang. That astute personage did not at all object to the project; he simply urged that it would be a mistake to assail the intended enemy too hastily. All this was perfectly well known to the Japanese statesmen, and they took the opportunity of bringing matters to a crisis, and of showing her rival that the naval and military power of Japan was not to be despised in the manner in which it usually was by the Chinese.

"The immediate results of the war are already very apparent. It has not only caused the naval and military power of Japan to be recognized, but it has also directed attention to the great development which that country has made in many departments of industry, and led British and continental manufacturers to consider seriously the probable effects on their trade and on commercial affairs in the east generally. It has also given an impetus in the same direction to China, and has raised the question whether Japanese or European influence is to dominate the Chinese industrial development. It has given Japan possession of the island of Formosa, which is not only very valuable on account of its mineral and other resources, but is also most important as a naval station. It has, on this account, afforded to Russia an opportunity of pressing her claims for recognition as an eastern power, probably, however, somewhat prematurely, and before she is prepared to take steps to enforce them. When, however, she has completed the Trans-Siberian Railway to Vladivostock, we may rest assured that she will not make that the terminus. The recent report that she had obtained permission from China to run a branch of that railway down the Liao-Tung province to Port Arthur, and, further, to station a part of her Pacific fleet in the best harbor on the east coast of Asia, at least indicated the direction of an advance which is certain to be attempted sooner or later, and which from Russia's point of view is, on the whole, to be justified. At any rate, we should have little difficulty in justifying it, if Britain were in her place. If this were carried out, and she were allied with France, and, as was recently the case with Germany, as a friendly neutral, the political position would become extremely serious for Britain, for it would change the whole balance of power in the Far West."

That these reflections are not without solid foundation is proved by a summary of Japanese progress and the influence upon eastern politics it has already exerted. The pace which has been thus set is so rapid that even the present generation may possibly see the awakening of the Chinese nation from the superstitions that have bound her for centuries.

Bimetallism.

THE able manner in which questions of industrial sociology are discussed in the editorial columns of technical journals has been more than once alluded to in the columns of this department. As an example of clearness in thought, comprehensive grasp of a much-debated question, and a talent for seizing upon and exposing the weak point in a plausible fallacy in few words, an argument against bimetallism in a speech made by the chancellor of the exchequer in the British house of commons during a recent debate is conspicuous, as may be gathered from an excellent editorial review of it in the *Journal of Gas Lighting* (March 24). An abstract of this review will suffice to show the skill with which the weakness of bimetallism is exposed.

The "gentlemen of England, who live at home at ease," have no conception of what it means to have to measure every commodity by a shifting standard of value. Yet this is precisely the problem which underlies all commercial questions over a wide area of the earth's surface. Apparently, it is also a condition of existence that a number of worthy and otherwise sane inhabitants of the British Isles wish to import for home experience. What else does bimetallism mean?

"Plain men may be pardoned for experiencing difficulty in understanding how a measure of exchange, or a system of currency, can have any connection with the intrinsic value of commodities. One would naturally suppose the operation of supply and demand competent to fix the value of anything marketable, whatever the nature of the medium in terms of which this value may be expressed. Thus a man gives so much labor in exchange for the price of a sheep. Originally, perhaps, the actual labor was recompensed by the actual animal; but the world has long since found it more convenient to interpose, in the course of all such bargains, a common standard of value, which is called 'money.' How anything in the money itself is to compel a man to work harder for his sheep, or to supply him with the sheep as a reward for a lessened amount of toil, does not appear in the nature of these things.

"The bimetallists seem to hold that there is something in money, apart from its exchangeable value. They appear to hold that, when money changes hands, it also, in some way, changes in value; and they declare that gold, for instance, has 'appreciated' in value, because more can be bought with it than was formerly the case. This argument, as the chancellor of the exchequer justly observed, would be at least intelligible, if it were borne out by facts. If a sovereign would buy more of everything now than it did (say) twenty years ago, one might see that it had attained a higher value; in other words, that it had appreciated. The fact, however, is altogether different. While some commodities, such as wheat, wool, and meat, are cheaper as measured by the gold standard, many other things, such as good investments, are considerably dearer. If a man goes into the market to buy a perpetual income of a pound a year, he is bent upon a commercial transaction as fully as when he sets out to buy a loaf of bread. Yet whereas in the one case he can get cheaper bread, or more bread for a stated amount of money, than was ever before obtainable since bread was first sold in the market-place, he must in the other case pay a higher rate for his fixed income than has ever been found necessary in the history of the world's finance. What, therefore, becomes of 'appreciation of gold' between these examples? It simply does not exist, save as a mischievous phantasy.

"The truth of the matter is that civilized and educated men are still as little prepared by their ordinary training as the untutored savage to perceive the operation of natural forces in the concrete effects that strike their consciousness. The world has been at peace, more or less, for a quarter of a century; and during this time means of cultivation, manufacture, carriage, and distribution of the necessaries of life have been more developed, and pushed farther than ever before, in different parts of the world. The average man knows this, in a vague sort of way, as he knows most things that do not very closely concern himself. But, when he sees an actual effect of these and other deep-seated, wide-spreading influences, he does not at first recognize it for what it is. Sometimes he is driven to fall back upon the supposition that it is the nature of the coinage he spends upon his purchases which affects their value. Just as well might the agriculturist regard the material of which his implements of husbandry are made as competent to affect the prospects of the harvest. Meanwhile, the average man of business will probably continue to act as though his first duty consisted in getting possession of as many sovereigns as possible, leaving it to subsequent inquiry to ascertain how to test them for appreciation or the reverse."

Statistics of Labor and Cost of Living.

MR. CARROLL D. WRIGHT, United States commissioner of labor, in a recent lecture at the School of Social Economics in New York, criticised the method of compiling statistics of wages and cost of living that up to a recent period has prevailed in British, continental, and American statistical work. The methods are shown to be crude and unscientific; from such methods only inaccurate and misleading results have been obtained.

The *Scientific American Supplement* (March 28) quotes liberally from this lecture, and presents its most important features. The reports of the British board of trade for the period of fifty years anterior to 1860 are declared to be no better than those compiled centuries ago. The attempt to show the number of persons receiving a particular wage, or a given rate, is of recent date.

Mr. Wright holds that the average earnings of workers in the mechanical and manufacturing industries of the United States, as presented in censuses of 1850–60–70–80–90,—obtained by dividing the total amount of wages by the total amount of wage-earners,—is of but limited value. The mere statement of an average is not sufficient. The mere statement of highest and lowest wages with an average is not sufficient.

"The scientific method requires to know how many persons in a given occupation are in receipt of wages above, and how many below, a given average." Averaging wages by adding together the highest and lowest wages paid in an establishment, and dividing the sum by two, as has often been done, is a vicious method, and seldom, if ever, gives a true average.

Inherent difficulties in the collection of original data, resulting from peculiar conditions, are exemplified as follows:

"A man will sometimes work at more than one occupation during a given period. Cases, indeed, often occur where a man will be engaged in several different occupations within a year. Even if he remain at one occupation, he may be promoted to a higher rate of pay, each advancing rate representing higher skill or larger industry and attention. Piece-workers are also the cause of many of the complications in wage statistics. The pay-rolls of works will often show only the amounts paid the workmen, no record being made of the time or of the number of pieces of work which the pay represents. The lecturer instanced the case of a coal mine, where the books must show only the successive dates at which the tons of coal mined were credited to the workmen. The miner may have worked all or only part of the time included between these dates. The output with which he is credited may represent his own labor only, or that of himself and his own half-grown son or other helper. It will be thus readily seen that it is at all times difficult, and often impossible, to ascertain the time of a piece-worker; and yet the time is an absolutely essential element in determining wages. A further difficulty is found in the fact that certain important employees work in gangs, crews, turns, shops, etc., different industries having different terms. The method of payment in such cases is liable to be as various as the terms themselves, and it is not universally the same in any given industry.

"Mr. Wright drew a distinction between nominal wages and real wages. Nominal wages are the actual cash payments made to employees, and, in considering their amount, no account is taken of the purchasing power of money. Real wages can be determined only by ascertaining the price of articles, or the purchasing power of the employee's wage. This is best done by taking the prices of articles entering into an individual's consumption at certain specified periods, and calculating how much a given amount of money will purchase at these periods. Mr. Wright considered that this method was a simpler, more common-sense, and less theoretical method than the European, with all its complication of piece statistics, weights, index numbers, etc. What one dollar will buy in flour or in any other commodity at different periods tests the question of real wages in a simple and effective manner."

Regarding the value of statistical work, the speaker said that "it is, or should be made, a part of the educational force of the country. A knowledge of statistics and how to handle them in a scientific sense is an essential aid to proficiency in medicine, law, journalism, and, above all, in politics."

Those interested in statistical studies will find this article a profitable study. All statistics should be carefully examined before they are accepted.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Industrial Sociology in the American, English, and British Colonial Magazines, Reviews and Engineering Journals—See Introductory.

*5262. The Present Value and Purchasing Power of Gold. H. M. Chance (Showing that the value of metals depends on the cost of production, and that, in accordance with this law, the inertia and tradition which now maintain the value of gold must sooner or later yield before the increasing volume due to decreasing cost of producing gold by underground mining). Eng Mag-May. 3300 w.

†5274. Industrial Communities. W. F. Willoughby (This article is the first of a series upon this subject to be published in successive numbers of the Bulletin. Each article will be complete in itself, giving the results of the investigation as to one or more communities. The investigation was made by the author during personal visits to the several communities dealt with. The information in this first part relates to the employees of the coal mining company of Anzin, and is presented in such a way as to furnish opportunity for statistical comparison of present and former conditions of men, the general and physical conditions of whose labor have remained practically identical, and the conclusion is that there has been a steady betterment of their condition in almost every particular). Bul of Dept of Labor-March. 15000 w.

†5275. Recent Reports of State Bureaus of Labor Statistics (Summaries: Connecticut, eleventh annual report, 1895; Iowa, sixth biennial report, 1894-95; Montana, second annual report, 1894; Nebraska, fourth biennial report, 1893-4; New York, twelfth annual report, 1894; North Carolina, eighth annual report, 1894; North Dakota, third biennial report, ending June 30, 1894; Pennsylvania, annual report, Vol. XXII, 1894; Rhode Island, eighth annual report, 1895; Tennessee, fourth annual report, 1895, and West Virginia, report for 1893-4). Bul of Dept of Labor-March. 5400 w.

†5276. Ninth Report of the Annual Statistics of Manufactures in Massachusetts (Summary and abstract). Bul of Dept of Labor–March. 1000 w.

†5280. American Trade with Spain and Spanish America (A consideration and discussion of the best means for facilitating commerce between the United States and Spain and Spanish dependencies). Consular Reports–March. 4000 w.

†5281. Spanish Industries (Enumeration and some statistics of the principal industries carried on in Spain). Consular Reports–March. 3000 w.

*5296. Industrial Problems in the Far East (Editorial dealing principally with these problems as related to the Chinese and Japanese empires which are considered not only as important to the politicians and manufacturers of other nations, but as affording a most interesting field of study for sociologists). Engng–April 3. 2000 w.

*5319. The Investor's Dilemma—A "Boom" in Credit (The fact that we are passing through the longest spell of the easiest money ever known, resulting in what the writer calls 'a boom in credit' is stated and effort is made to explain this anomalous financial situation, by the comparative lack of adequate outlets for money, the heavy fall in prices of commodities, and the financial unrest in America). Banker's Mag, Eng–April. 5000 w.

*5320. United States Loans: Their Peculiar History. Alexander D. Noyes (The success of the late United States loan is regarded as a result of luck, while shortcomings and blunders in the details of the negotiation are charged. The financial administration of Mr. Carlisle is severely criticised. His attitude toward Wall St. is characterized as childish, but it is admitted that the attitude of the partisan press has made Mr. Carlisle's administration particularly difficult). Banker's Mag, Eng–April. 2000 w.

5322. "Invention"—The Indefinable Requirement of the Patent Law. W. H. Smyth (The first part is an exceedingly able argument sustaining the thesis that the word "invention" as used in patent laws, is indefinable, that until recently it has been a dead letter, and that in its modern use it is a metaphysical myth). Min & Sci Pr–April 4. Serial. 1st part. 1600 w.

5327. The Choice of Location for Manufacturing Plants (Editorial in which the success of a manufacturing industry is considered as depending upon abundant capital, good location, the most modern machinery, and good management. The article is mainly devoted to the topic named in the title and closes with a tabulated statement of the location of the principal manufacturing industries in the United States). Eng News–April 9. 4000 w.

†5333. Is Poverty Diminishing? J. A. Hobson (The estimate of either wealth or poverty, in this paper, is made upon the basis of the quantity of marketable goods represented by income. The statistics of pauperism, showing a reduction in the number of English paupers, are not thought to be evidence of diminishing poverty, this apparent diminution resulting from administrative changes made by boards of guardians. Reports of the labor commission are held to be defective in their methods of making averages, etc. The conclusion is that while poverty, as measured by income, is apparently decreasing, as measured by the quantity of marketable goods represented by income it is not diminishing; while subjective, or felt poverty is growing with the widening gap between legitimate human desires and present possibilities of attainment). Contemporary Rev–April. 6800 w.

†5359. Cardinal Manning—A reminiscence. Sidney Buxton (Details particulars of the great influence of the famous cardinal upon social and labor questions, in particular recounting recollections of his attitude in the great dock strike, and his position as an exponent of new ideas). Fortnightly Rev–April. 9000 w.

*5476. Wages in the Engineering Trade. J. Stafford Ransome (The investigation is chiefly confined to inequalities in different parts of Great Britain, and the reasons for it are sought. The first part deals with reasons popularly assigned but regarded as inadequate). Eng, Lond–April 3. Serial. 1st part. 2000 w.

*5503. The March of Invention (Editorial, the point of which is that inventions which much affect the progress of civilization, require a good deal of time before assuming such a commanding position as to divert the course of national or social life). Engng–April 10. 2800 w.

5525. Use of Credit Instruments in Business (Review of Comptroller Eckels Cincinnati address in which the tendency to the decreased employment of metal money is shown to be dependent upon, and strictly related to improved methods of banking exchanges, which are constantly lessening the necessity of using a metal money; and in which it is asserted that the clamor raised about the lack of money for ultimate redemption is more for purposes of confusion than for argument. Investigation has shown that even in retail business three-fifths of the payments are made by credit instruments). Bradstreet's–April 25. 900 w.

*5572. The Paris Exhibition—1900 (Prospects and probable effects upon commerce editorially considered). Mach, Lond–April 15. 1000 w.

*5573. Patent Law Reform (A criticism of present English patent law and a demand for a reform that shall in some measure approximate in liberality, the United States patent laws). Mach, Lond–April 15. 1000 w.

*5575. A New Remedy for an Old Evil. E. J. Smith (The first of a series of articles by the chairman of the Bedstead Makers' Association, with editorial, commenting favorably upon a speech of Mr. Chamberlain, British Colonial Secretary, with reference to the scheme, and appreciative remarks of other public men, and upon Mr. Smith's movement, by which the profits of the Association have not only been increased, but whereby the wages of workmen have been increased 25%, while the product has been much improved in quality). Mach, Lond–April 15. 6200 w.

*5589. Shipping Bounties of Foreign Countries and Their Effect (The instances of successful results are stated to have been few, and a running review of the bounty system, as it has been tried by various European governments, is presented). Engng–April 17. 2500 w.

†5652. United States Trade with Japan (Commercial education in Japan; Japanese manufactures, agricultural and mineral products; wages; foreign vs. Japanese products; Japanese banking and foreign trade; Japanese producing capability; effects of opening up China to trade; imports and exports of Japan; and how to increase American trade in Japan, are topics treated in this report). Consular Reports-May. 3800 w.

†5653. Progress and Present Condition of Japan (Observations upon the army, the marine, railway systems, the schools both public and private, a notable characteristic of the school system being enforced military drill). Consular Reports-May. 1300 w.

†5654. American Manufactures in Japan (An attempt to answer in a comprehensive manner, an inquiry made in department instruction in regard to the prospects of American competition in the Japanese empire. The writer thinks that a mistake is made by the American manufacturer in the attempt to educate the Japanese to our way of doing things, instead of accepting existing conditions, and attempting to supply what the conditions call for, as European competitors are doing). Consular Reports-May. 1000 w.

*5673. Foreign Competition in the Iron Trade. H. M. Punnett (The views of the author are interesting as he is understood to be the mouthpiece of the opinions of the Midland Iron & Steel Wages Board). Eng, Lond-April 17. 4500 w.

†5687. The Argentine Republic: Commerce, Finance, and Industries in 1895 (Copious statistics, covering the entire commerce of the country, with short papers on various branches of commerce and industry, by consuls Baker, Buchanan, and Stephan). Consular Rpts-April. 17500 w.

†5688. Shipbuilders' Strike in Belfast (The full account of this noted strike from its commencement, Oct. 11, 1895, to its termination, Jan. 27, 1896. The strike resulted in an advance in wages of about four cents per day of nine hours. Twelve thousand workmen were thrown out of employment in the Belfast district for over four months, at the approach of winter, and many families were reduced to the starvation point). Consular Rpts-April. 3300 w.

*5694. Need of Better Homes for Wage-Earners. Clare de Graffenried (A comparison between the slums of American and foreign cities is made which is unfavorable to the former. The big tenement house is more used in American cities than abroad, and is regarded as a menance to the moral, mental and physical health of the urban poor. The condition of the poor in the chief American cities is reviewed. It is insisted upon that it would not only pay financially to provide better homes for the poor, but that it would tend to elevation of character among them, and its influence would be adverse to strikes. Many excellent points and suggestions are made). Forum-May. 4400 w.

*5695. Cultivation of Vacant City Lots. Michael A. Mikkelsen (Account of the system adopted by Mayor Pingree of Detroit, followed by a discussion favorable to the advantages and practicability of this mode of helping the poor of our large cities). Forum-May. 2000 w.

*5696. The Unaided Solution of the Southern Race Problem. A. S. Van de Graaff (The presence of an undue proportion of negroes in the southern states is the condition that gives rise to this race problem, according to the views of the author. The general problem resolves itself into the questions:—Is the presence of the negro in relatively excessive numbers to differentiate the South from the North? Is the South, or any portion of it to be dominated industrially, socially, or politically by the negro? Are there to be in the South race wars, race riots, or other forms of lawless aggression by one race upon the other? These questions are discussed at length). Forum-May. 8000 w.

*5698. Bank Monopoly—Specie Contraction—Bond Inflation. Albert Roberts (In this article the national bank system is characterized as the most brilliant and audacious scheme of usury ever devised in the cunning brains of far-seeing financiers. The article is an argument in opposition to this system. The further issue of bonds is deprecated. The writer thinks that bond issues are the root of present financial evils). Arena-May. 3300 w.

*5700. The Industries of Valparaiso (Abstract of an article in the *Chilian Times*. Statistical in character). Bd of Tr Jour-April. 900 w.

*5701. Tariff Changes and Customs Regulations (Includes Sweden, Netherlands, France, Algeria, Portugal, Spain, Italy, Greece, United States, Brazil, British India, Trinidad and Tobago, and Western Australia). Bd of Tr Jour-April. 6500 w.

†5741. Foreign Trade of Siam (The most extended report yet made upon Siamese commerce, prepared with special reference to the opportunity open to exporters of the United States). Consular Rpts-May. 4000 w.

*5769. England's Return to Protection. George Gunton (Reprinted from the *N. Y. Press*. This article holds that at the end of a fifty years' experiment with free trade, England is now taking steps to return as gracefully as possible to the system of protection, and that this is what intelligent protectionists have predicted would be the final outcome). Gunton's Mag-May. 2400 w.

*5770. Credit Associations in Germany (The growth and prosperity of the two systems of co-operative, or poor people's banks, in Germany, known as the Shulz-Delitsch system, and the Raiffeisen banks, are considered an indication of a tendency backward toward communistic or tribal methods, which, if they contain a better means of giving credit to the poor, will command the closest attention and respect of the economic world). Gunton's Mag-May. 3300 w.

*5771. Our American Proletariat (Its menacing conditions. The position is taken that true reform should begin with effective restriction upon immigration and be followed by state and national legislation tending to raise the standard of living of American laborers). Gunton's Mag-May. 1300 w.

*5772. Political Revolution of the South. Jerome Dowd (In this paper a hopeful view is taken of the future of the South, based upon the literary awakening within the last few years, and the rapid organization of clubs and libraries). Gunton's Mag–May. 2400 w.

*5773. Non Partisanship a Municipal Necessity. D. H. Bolles (The propositions maintained in this paper are (1) partisan control of municipal administration is hostile to the municipal welfare; (2) the only hope of municipal emancipation lies in the fearless and faithful enforcement of the non-partisan policy. Hence (3) the non-partisan has vindicated his right to a foothold, and to the respectful consideration even of his adversaries). Gunton's Mag–May. 1400 w.

†5778. The Development of the Monetary Problem. Logan G. McPherson (The evolution of money from the earliest times when all trade was in the form of barter, and of banks from simple depositories of commodities, are first considered. The principle that money represents human effort as measured against other effort, is then enunciated, and the tendency of civilization toward the increased use of paper representatives of value is the final topic discussed). Pop Sci M–May. 4000 w.

†5779. Pending Problems for Wage-Earners. A. E. Outerbridge, Jr. (A study of the question of the management of employees from a common-sense, as well as a just and humanitarian point of view, is the purpose of this paper). Pop Sci M–May. 6000 w.

5791. British View of the Tinplate Trade. (Abstract of an article in the *Iron and Steel Trades Journal* (London). The opinion is expressed that the tin plate industry has taken firm root on American soil, and all that can be said or done will not alter the fact. The advantage of cheaper English labor is thought to be fully offset by the more modern American plants and labor saving appliances). Bradstreet's–May 2. 800 w.

5818.—$1. Bryce's "American Commonwealth." E. J. James (A criticism of the book named in which, though its purposes and execution are in general approved, certain alleged inaccuracies are pointed out). An Am Acad–May. 12000 w.

5819 —$1. Political and Municipal Legislation in 1895. E. D. Durand (The more important and generally familiar phases of political and municipal legislation are stated and briefly commented upon. Among these are legislation upon suffrage, ballot reform, voting machines, corrupt practices, nominations, legislature and state officers, county government, general municipal legislation, municipal service reform, local indebtedness, &c). An Am Acad–May. 4200 w.

†5825. The Agricultural Problem. M. B. Morton (In this paper the agricultural problem is considered the most vital in American politics at the present time, and some striking allegations are made. The American farmer, it is said, earns no more than a living, and half of what he makes is consumed in taxes, direct and indirect. It is not therefore strange that he is in distress, and is willing to try almost anything for relief). N Amer Rev–May. 1000 w.

*5826. National Currency and Hard Times. H. H. Trimble (Answers negatively the questions (1) Did the demonetization of silver cause a scarcity of money? (2) Did it reduce the volume of currency in America? (3) Did it cause the hard times which overtook us in 1893? Assigns as some of the more potent causes (1) Unwise and reckless speculation; (2) the rapid multiplication of labor saving machinery; (3) labor strikes and over-production. Tariff legislation is held not to have been a cause, but it acted to retard recovery). Am Mag of Civ–May. 2500 w.

*5827. A Cabinet Secretary of Labor. Morrison I. Swift (Starts out with the proposition that governments that ignore the labor question cannot stand, and that henceforth the question must be how government hands are to be laid on. A system of government avowal and comprehension of labor, by placing the national department of labor on a par with the leading departments of State, and giving its chief administrative position as a cabinet secretary, is advocated as a step in advance). Am Mag of Civ–May. 3800 w.

*5828. "Are We a Nation of Rascals?" A Rejoinder. Joseph Oker (Reply to an article under this title, by John F. Hume, in the March number of the same magazine, which by charging dishonesty upon congress, seems to be rather an agreement with, than a refutation of Mr. Hume's affirmative). Am Mag of Civ–May. 4000 w.

*5829. The Ethics of the Single Tax. George Bernard (The author admits that if the proposed single tax is not in itself right, it will do a great wrong, and then undertakes to show that it must be right because it conforms to fundamental principles of ethics, and conflicts with no one of the sacred rights of humanity). Am Mag of Civ–May. 3800 w.

*5830. New Commercial Alliances. Julian R. Elkins (The prediction is made that the United States is again to be the commercial mistress of the high seas, and an attempt is made to show that all signs point to the fulfillment of this prophecy. A good deal of rhetoric of the "spread eagle" variety is indulged in). Am Mag of Civ–May. 1700 w.

5858. The Future of Cotton Manufacturing in the South D. A. Tompkins. Paper read before the annual meeting of the New England Cotton Manufacturers' Association (Reviews the changed conditions since the war, and their effect on manufactures, and considers the subject in relation to raw material, labor, climate, markets and transportation facilities). Mfrs Rec–May 1. 5400 w.

†5917. The Political Darwin. Ariel (A humorous satire upon modern financial bunglers, who are styled "three inch politicians" and treated as being in the first stages of evolution toward higher development. The folly of attempting to hurry up this development also comes in for an amusing bit of humorous writing). Ind Engng–April 4. 1000 w.

MARINE ENGINEERING

White Metals for Bearing Surfaces.

Mr. Robert Davison, in a paper read before the Bristol Center of the Institute of Marine Engineers, called attention to the trying conditions to which marine engines are subjected, and the importance of attention to frictional bearing surfaces in this class of steam-engine work. We herewith present an abstract of this excellent practical paper, the entire paper being printed in *The Practical Engineer* (April 17).

"White metal has come into very extensive use, and is applied with advantage to nearly all wearing surfaces, particularly crank and main shaft bearings, guides, and valve faces. In some cases, however, such as in cross-head and pump-link brasses, it does not appear to give such satisfactory results. This may possibly be accounted for by the comparatively small amount of movement in the latter cases, and consequent incomplete lubrication. In white-metalling a new bearing, a good plan is to have the bearing cast with longitudinal recesses or channels about ¾ in. apart, and a circumferential recess at each end of the brass of the same depth as the other recesses and into which they lead. The bearing should be well heated, and the white metal poured into the channels so as to fill them and stand 1/32 in. above when finished. It will now be seen that the white metal in the end channels serves to keep the lubricant from running out of the bearing. The bearing is then bored and dressed in the usual way. One of the smoothest bearings I have ever seen was that of a crank shaft fitted with brasses hexagonally shaped on the outsides to fit the ordinary pedestal and cap. These brasses, no doubt, from a point of economy, had been cast with these rectangular holes in the top half brass. I remember having to assist in stripping this shaft, and, on removing the cap, a small quantity of oil was found retained in each of the holes mentioned. This, I think, goes to prove that, when sufficient bearing surface is provided, it is of advantage, when metalling, to keep the recesses closed, by forming the circumferential end channel described above. With old worn bearings, in which the thickness will not permit of recesses being formed, the first step is to have them thoroughly cleaned and tinned. This cannot be done too carefully in order to obtain a satisfactory job. The metal may then be applied in strips, or to the whole surface, if deemed necessary. It is usual to well heat the bearing in all cases when applying the white metal, to avoid the risk of the metal getting loose when cooling. If this is done, and proper precaution is taken in the tinning, I am confident that there is no likelihood of this taking place, and consequently see no necessity for drilling dowel holes, as is sometimes done, with the object of drawing the metals well together. Those who are inclined to be timid in trusting to tinning operations alone may possibly be relieved of their doubts by the following instance. A large wrought-iron half strap for a paddle-wheel was tinned on its inner surface, afterwards laid in loam, and white metal poured from a ladle into the space prepared for it. It was then taken out of the mould and left to cool. When preparing it for machining, the points of the straps were found to have closed towards each other to such an extent that it was necessary to take a cut over the face of the joint to make it straight. This alteration in shape can only be accounted for by the cooling process. The white metal, being so much hotter than the strap, had contracted to a greater extent, and so caused the deflection. This also, I think, goes to show that the tenacity of the white metal to that to which it may be affiliated is very great. With cast-iron blocks it may be prudent to have a shoulder on the sides next the joints to support the white metal, or even to drill dowel holes. Tunnel bearings, which have not been previously fitted with white metal, can be dealt with in a similar manner to worn brass bearings."

In metalling brass eccentric straps, the thickness and strength at the crown of the strap may be maintained, but the author regards cast-iron as the best material for marine engine eccentric straps, provided ample wearing surfaces are supplied. For guides white metal is also good, but oil channels should be formed in the faces. White metal is recommended for slide valves. It should be inserted in holes in the faces of the valves in such manner that the line of margin of the plugs in one row will overlap the line of margins in the adjacent rows between the plugs in these rows. White metal is also recommended to be put between the sleeves of the tail-shaft, its effect being beneficial in preventing corrosion. For feathering-gear eccentric straps in paddle-wheel engines white metal is preferable to brass for liners. Of course, with the variety of white metals on the market, there is some difference in quality, but the author very properly declined to recommend one more than another, leaving this matter to the judgment of engineers.

Compound Marine Boilers.

In a paper read before the Institution of Naval Architects, reported in *Engineering* (April 3), Colonel N. Soliani, director of naval construction in the Royal Italian Navy, calls attention to the natural reaction in favor of ordinary marine cylindrical boilers, which has followed the "advance of water-tube boilers in the field of steam navigation." The latter are believed by many, although inferior in certain respects, to possess features of great value for marine purposes, not yet fully secured in the new boilers. This view refers, however, to boilers for ships other than torpedo craft, which have requirements that only water-tube boilers can now fulfil. Within these limits the contention in favor of cylindrical boilers does not appear groundless.

In fact, the marine cylindrical boiler is not a new production of the inventive genius of man, but is the result of the experience of two generations at sea. It is the last stage of development and improvement reached, under existing practical conditions, of an "organ" in the evolution of the entire "organism," "the steamship," to which it belongs. And, in so long an adaptation to surrounding conditions, the marine boiler, from the early types to the present one, has, in effect, developed features of real fitness for ocean navigation, and has reached a state of perfection not easy to attain immediately with any new boiler.

The prominent features of the modern marine cylindrical boilers are well known, —*viz.*, efficiency, simplicity of parts, fewness of bolted joints, durability, easiness of inside inspection, fitness to available space on board ships, small liability to derangement, possible concentration of large power in few boilers (so reducing number and complications of pipes and fittings), steadiness of action, by which water feed and steam pressure are under easy control, facility of repair of the heating tubes under steam, adaptability for temporary use of sea water for supplementary feed, etc.

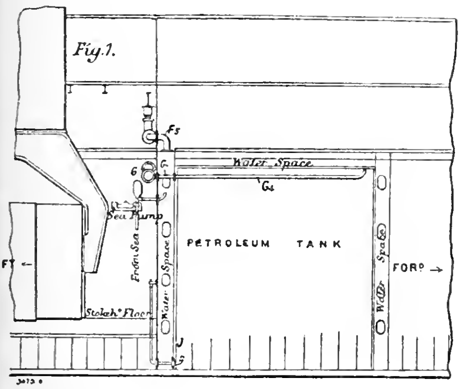
Although some of the foregoing characteristics may be claimed also for water-tube boilers of various types, others are certainly special to the cylindrical boiler, and it is to these important features that cylindrical boilers owe their success in the domain of ocean navigation, and the present campaign in their favor.

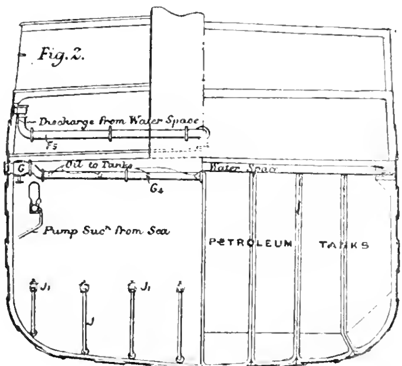
Only in France have water-tube boilers been much used by the mercantile marine. Colonel Soliani does not think the "proclaimed unsuitableness" of cylindrical boilers for forced draught is yet proved to be unavoidably due to the organic constitution of this type, but intimates that this unsuitableness may be due to the magnitude of the extra strain, and the suddenness with which it was applied, before the boilers had had time to adapt themselves to the new demands made upon them. In support of this view, he cites results obtained with Servé tubes and the Howden and Brown systems of combustion; and he adds: "while it is pretty certain that, owing to certain important advantages which water-tube boilers offer, principally for navy purposes, the difficulties which still beset their general adoption will be vigorously attacked and finally overcome, I think, from what has been said above, that cylindrical boilers not only have, as yet, a great power of endurance in the mercantile competition, but that there is still room on their side for further improvement, by which their vitality may be increased, and the struggle prolonged, even for navy purposes, with advantage to the great interests involved."

He then proceeds to describe, with illustrations, a suggested improvement in cylindrical boilers, consisting in compounding them with water-tubes, and intended to conserve the valuable characteristics of both systems. This part of his paper is technical, and cannot be here reviewed; but it is suggestive of possibilities of great interest to marine engineers.

Oil-Tank Steamers.

THE cuts herewith reproduced are from *Engineering* (April 17), and the descriptive matter is an abstract of a communication to that paper by Joshua Phillips. Referring to the ineffectual attempts made to extinguish a fire which recently broke out in the Dutch oil-tank steamer Bremerhaven, and came very near destroying the ship, he says that vain attempts had been





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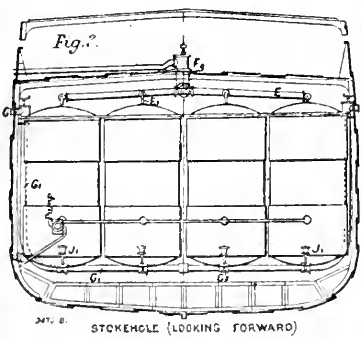
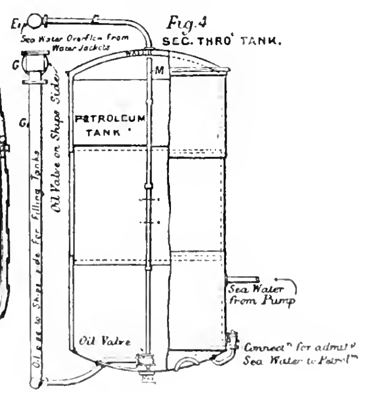


STOKEHOLE (LOOKING FORWARD)



made to put out the fire (which started in the fire-room) by means of wet mats and sail-cloths; and that he has found the application of sand to be one of the best means of quenching shallow depths of burning oil; and, in the by-laws which he was recently commissioned to draw up for the importation of crude petroleum in bulk into England, he insisted that there should be a supply of sand on the steamer and landing-places during discharging-operations.

There can be no doubt that, if the cofferdams are kept empty, and periodical observations made for leaks into them from the oil tanks, it would be safer than filling them with water and observing the first indication of leakage in the stokehole. The principal danger from this system would be that, should there be a leak of oil into the empty cofferdam, which would be pumped back into the oil tanks, it would soon contain an explosive mixture of petroleum vapor and air, and great care would have to be exercised to prevent any flame from getting near it. In such case any openings should be carefully covered with wire gauze.

While it is seen that vessels, when loaded with petroleum, are not altogether free from risks of fire and explosion, there can be no doubt that, after being unloaded, the risk from explosion is greatly enhanced.

Wire gauze should play a more important part in the handling of petroleum in bulk than it does. The writer recently superintended the discharge of two tank steamers containing about four thousand tons of crude petroleum (flashing below 60 deg. F.) in the River Tees. The oil was pumped from the steamer into tank lighters holding about two hundred and fifty tons, and then towed up the river to the landing-place, a distance of three miles; the oil was then pumped from the barge into ten-ton railway-tank wagons, nine of which were filled at the same time. All openings or ventilators on the ship, barge, and railway tanks were covered with wire gauze of thirty-six meshes to the lineal inch, and the funnels of the steamers, tugs, and locomotives were covered with spark-arresters. With such precautions the discharge was conducted with perfect safety. This is the first time crude petroleum (flashing below 73 deg. F.) has been imported and so discharged in England, and there can be no doubt that, if the regulations for its safe handling should be rigorously enforced, risks from fire and explosion would be very remote. Coming from an authoritative source, these practical suggestions are worth consideration.

Tests of Boiler Plates.

THE recent change in rules for testing boiler plates, adopted by the board of inspectors of steam vessels, excites much adverse comment. *Engineering News* (April 9) takes up the discussion, and unsparingly criticises the action of the board. It says: "The method of adopting rules for this board seems to be to get the manfacturers of plate to say what specifications they would like to have, and then give them what they ask for. As a consequence, the shape of test piece specified by the rules of the board for testing boiler plates made of iron has been for the past twenty years so bad that it has been condemned by every engineering writer who has had his attention called to it. Up to 1894 these rules applied also to steel, but since that date the shape of test pieces for steel plate has been made different from that for iron plates. In 1894 the tensile test piece for steel was specified to have the straight portion of a length at least eight times the width multiplied by the thickness, and of a width of one inch. Why the standard length of eight inches between gage marks, adopted almost universally by testing engineers both in Europe and in the United States, was not chosen, we cannot imagine. The new rule, which is said to have been adopted after considering the changes urged by representatives of steel-plate manufacturers, specifies the following:

"'The straight part in the center shall be 9 in. in length and 1 in. in width, marked with light prick punch marks at distances 1 in. apart, as shown, spaced so as to give 8 in. in length.

"'The sample must show, when tested, an elongation of at least 25 per cent. in a length of 2 in. for thickness up to ¼ in. inclusive; and in a length of 4 in. for over ¼ to 7-16 in., inclusive; in a length of 8 in. for 7-16 to 1 in., inclusive; and in a length of 6 in. for all thickness over 1 in.

"'The reduction of area shall be the same as called for by the rule of the board. No plate shall contain more than .06 per cent. of phosphorus, and .04 per cent. of sulphur.'

"If we correctly understand this rule, the elongation of a specimen of plate 0.24

in. thick would be measured over a gaged length of 2 in., but, if the plate were 0.26 in. thick, it would be measured over 4 in. The allowance of phosphorus up to 0.06 per cent. is extremely liberal to manufacturers, and it would indicate that they had a good deal to do with framing the specification."

Following this criticism, mention is made also of a standard specification, established by steel manufacturers, which is regarded as considerably better than the specifications of the board of inspectors, but open, nevertheless, to just criticism. This specification requires that "the elongation shall be measured on an original length of 8 in., except when the thickness of the finished material is 5-16 in. or less, in which case the elongation shall be measured in a length equal to sixteen times the thickness, and except in rounds of 5-8 in. or less in diameter, in which case the elongation shall be measured in a length equal to eight times the diameter of section tested."

Engineering News calls attention to the fact that, in the application of this specification, "if the test specimen had a thickness of $\frac{5}{16}$ in., or a diameter of ⅝ in., the elongation would be measured over a length of 5 in., but, if the thickness or diameter were a trifle greater, it would be measured over 8 in. In other ways this specification is objectionable.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Marine and Engineering Journals—See Introductory.

†5258. Free Port of Hamburg (Historical and statistical article, giving voluminous statistics of trade at this port. Also fully dealing with the regulations of trade at the port). Consular Reports–Feb. 27000 w.

†5259. Free Port of Bremen (Complete historical and statistical account with regulations, by-laws, etc). Consular Reports-Feb. 4800 w.

†5260. Free Port of Copenhagen (Circular issued by the Copenhagen Free Port Co. at the opening of the port in Nov., 1894, setting forth its purpose, commercial advantages, accommodations for vessels, regulations, by-laws, schedule of taxes, etc., with supplementary report dealing with the effect of the free port on trade). Consular Reports–Feb. 9400 w.

†5282. The Port of Nantes (General description and statistics). Consular Reports–March. 2500 w.

*5294. Circulation in Water-Tube Boilers. W. H. Watkinson (Paper read before the Inst. of Naval Architects. The main object of this paper was to call attention to a series of models shown in action, and so constructed that the circulation, set up by heat in the furnaces, could be observed. The models included the more important types of this class of boilers, as applied to marine service, and the paper is a valuable contribution to the literature of the subject). Engng–April 3. 3800 w.

*5295. Compound Marine Boilers. N. Soliani (Paper read before the Inst. of Naval Architects. An able argument setting forth the advantages of this type for marine service, more particularly for the merchant marine). Engng–April 3. 1400 w.

5466. Inclined Planes for Boats—Their Early Use and More Recent Examples (Illustrated description of inclined planes used to shift boats in canals, lagoons, etc., from one plane to higher or lower planes. This device, though it preceded locks, is still in use in the Orient). Sci Am Sup–April 18. 3500 w.

5467. Ship Protection by Discrimination (An editorial argument supporting the policy of discrimination and setting forth its effects for the first thirty years after the organization of the United States Government as contrasted with effects of the opposite policy during the three decades ending in 1890). Sea–April 16. 1600 w.

5470. Aluminum in Shipbuilding (Review of a report recently made by M. Guillemoux upon the condition of two aluminum vessels of the French navy, which have been in use two years. The metal was found to have been attacked by salt water where the hull had been imperfectly protected by the paint). Ir Age–April 16. 500 w.

*5478. The Japanese Warship Fuji (Illustrated general description). Eng, Lond–April 3. 700 w.

*5479. The Austrian Torpedo Boat Viper (Illustrated general description which is also made the occasion for a general discussion of the policy of building vessels of the destroyer type. Cuts show arrangement of the Yarrow boilers in Dutch cruisers). Eng, Lond–April 3. 1800 w.

*5504. H. M. S. "Renown" (Editorial discussion of the points in this new ship, which made her full speed contractor's trial trip on April 6, the ship being the prototype of the five new battleships of the 1896 programme). Engng–April 10. 1800 w.

*5505. Microscopic Flaws in Steel. A. E. Seaton (The causes of mysterious fractures in the steel used by marine engineers as revealed by the microscope. Read before the Inst. of Naval Architects). Engng–April 10. 2300 w.

*5506. Some Geometry in Connection with the Stability of Ships. J. Bruhn (Read before the Inst. of Naval Architects. Geometrical principles are regarded in this paper as at the very root and foundation of the question of stability in ships, and the discussion, after a brief review of the methods hitherto used, proceeds on geometrical lines to the construction of a set of cross-curves of stability for inclinations of from 90 to 180 degrees, when the corresponding curves from 0 to 90 degrees inclination are known). Engng–April 10. 4300 w.

*5556. Assistant Engineers in the Royal Navy (Text of the regulations for the guidance of candidates for direct appointments in the Royal British Navy, indicating very clearly the nature of the examinations through which candidates for the post of assistant engineer are required to pass). Eng, Lond–April 10. 8000 w.

*5576. White Metals for Bearing Surfaces. Robert Davison (Extract from paper read before the Bristol Centre of the Institute of Marine Engineers. Deals with the application of these metals to the working parts of marine engines. The higher pressures and speeds now in vogue have greatly increased the use of these metals, and their substitution for brass where the latter has been used in engine construction). Prac Eng–April 17. 1700 w.

*5590. Oil Tank Steamers. H. Joshua Phillips (Fire risks in oil tank steamers and how to lessen them. Best method of extinguishing shallow depths of burning oil). Engng–April 17. 500 w.

*5591. Stresses Due to the Pitching of Ships. A. Kriloff (Paper read before the Institution of Naval Architects. A new theory of the pitching motion of ships on waves and of the stresses produced by this motion. The treatment is mathematical, employing the calculus, and the text is illustrated by diagrams). Engng–April 17. 3000 w.

5635.—$1.50. Some General Notes on Ocean Waves and Wave Force. Theodore Cooper (A learned discussion, illustrated by diagrams, comprising formulæ and examples of wave action and force compiled from a variety of sources). Trans Am Soc of Civ Eng–April. 6000 w.

†5655. Merchant Marine of Japan (Abstract from a series of articles recently published in the *Nichi Nichi Shimbun*, with tabulated statement of vessels and tonnage showing the growth of the Japanese merchant marine during the ten years ending with 1894). Consular Reports–May. 400 w.

5685. Rigs of Sailing Vessels (Description of the various rigs of sailing vessels with 28 diagrams). Sci Am Sup–May 2. 1100 w.

*5699. The Condition of the French Mercantile Marine (Abstract of an article in *Journal des Debats*, upon the present unsatisfactory condition of the French mercantile marine, expressing the fear that it will have ere long, declined into complete ruin in face of the formidable competition which is destroying it. This view is supported by references to statistics of naval construction). Board of Tr Jour–April. 1500 w.

5707. An Open Letter. Alex. R. Smith (This letter is addressed to John R. Bartlett, President of the Nicaragua Company. It urges the alleged fact that the advantages to the industry of marine engineering in the United States, provided it be made an exclusively American enterprise, have been inadequately presented, and that the lukewarmness of the advocates of the canal, is due to this fact. The writer holds that if the canal were constructed on this basis, 500 to 1000 modern ships would be needed, an expenditure of from $100,000,000 to $200,000,000 would be distributed among shipyards employing American labor, and that from 40,000 to 50,000 Americans could be furnished with profitable employment afloat. These statements properly and energetically placed before the American public, would, in the writer's opinion make American labor clamorous for the construction of the canal). Sea–April 30. 1500 w.

5708. Queen of Battleships (The Massachusetts makes a record of 16.15 knots. For six hours she steamed 17.3 knots, which eclipses all records for vessels of her class. A premium of $100,000 earned by her builders). Sea-April 30. 1700 w.

*5797. A Notable Clyde-Built Schooner (Illustrated general description). Eng, Lond–April 24. 900 w.

*5801. Double-Acting Oil Engines for Boat Propulsion (Illustrated general description). Engng–April 24. 500 w.

*5802. Lower Thames Navigation (The imperative nature of improvements in the navigability of the Thames River, made necessary by the modern increase in size of vessels, and the specific improvements needed are discussed editorially). Engng–April 24. 2000 w.

*5805. The Non Uniform Rolling of Ships. R. E. Froude (Paper read before the Inst. of Naval Archs. Criticism of a paper read by the eminent M. Emile Bertin at a meeting of the Inst. in 1894. The first part regards M. Bertin's system as needlessly retrograde as would be a reversion to bows and arrows from modern rifles). Engng–April 24. Serial. 1st part. 3000 w.

†5824. The Engineer in Naval Warfare. Symposium by George W. Melville, W. S. Aldrich, Ira N. Hollis, Gardiner C. Sims, and George Uhler. The great and increasing importance of the engineer in marine warfare, and the needs of the future are herein set forth). N Amer Rev–May. 21700 w.

†5886. The Western River Steamboat. William H. Bryan (Read before the A. S. M. E. Defense of the present type of western river-steamer as adapted to the commerce it is employed in, and an answer to criticisms that have been made upon them, as not sharing the improvements that have marked our lake marine construction). Trans Am Inst of Mech Engs–Vol. XVII. 1800 w.

5898. United States Revenue Cutter No. 3 (Illustrated detailed description). Am Mach–May 7. 1600 w.

5902. The Speed Trial of the United States Battleship Massachusetts (Illustrated popular description). Sci Am–May 9. 900 w.

MECHANICAL ENGINEERING

The Manufacture of Steam.

IN our December number we presented an account of the organization of the Steam Users' Association under the general supervision of Mr. Edward Atkinson and under the special directorship of Professor Peter Schwamb, of the Massachusetts Institute of Technology. Some results of this effort are now presented by the association in a series of circulars, entitled "*Progress Reports*," from which the general character of the work can be better appreciated than it could from the announcement. Circular No. 3 is a pamphlet of twenty-six pages. It is a preliminary report of a comparison of the efficiency of different fuels, and is submitted to members with the statement that, as there has not yet been sufficient time to complete the record and tabulate collected data, it will be subject to revision.

An introduction by Mr. Atkinson concludes with a request for suggestions for investigation in Great Britain and on the continent, which Mr. Hale, expert of the association, will soon visit. Mr. Atkinson also calls attention to his own experiments in economizing heat for cooking purposes, and propounds the theory that the application of the principle of encasement with a non-heat-conducting material, which he has so successfully used in his well-known cooking apparatus, is the rational way to economy in the manufacture of steam. This is followed by "Progress Report, No. 3," prepared by Professor Schwamb and Mr. Hale, which repeats the explanation that the appended tables are not complete, and that the conclusion derived from them must be, for the present, regarded as provisional only. For this reason we are not permitted to make excerpts from the circular, though there are some passages in it which are of interest, particularly some remarks on the use of culm in a large iron-melting establishment, in which the owner, instead of being obliged to purchase, was paid ten cents per ton for removing the fuel subsequently utilized in his furnace.

Circular No. 4 contains a preliminary report by Mr. Atkinson upon the cost of delivering coal to boilers, and "Progress Report, No. 4," prepared by Professor Schwamb and Mr. Hale. This is a preliminary report on cost of delivery of coal to boilers.

Examinations of plants with coal-handling appliances burning fifty tons per week have disclosed at least one case where the cost of handling reaches ninety cents per ton. It is thought the cost of handling in plants of this capacity ought not to exceed fifty cents per ton. An average labor-cost for hand-fired plants exceeding a weekly consumption of fifty cents per ton is found to be eighty-seven cents per ton. This, it is thought, could also be reduced to fifty cents per ton. The data upon which this report is founded were obtained in response to a circular of inquiry, accompanied by a printed blank form in which answers to special queries could be briefly inserted.

"Circular No. 4" is also accompanied by a blank form prepared by Professor Schwamb and Mr. Hale, designed for data relating to cost of labor in producing steam. Of this form, the authors say that it is the result of their consideration of conditions observed in the inspection of some twenty to thirty establishments. It is admitted that in the inspection some obtainable information may have escaped the notice of the expert, and that mistakes in the record may have been made. Corrections are, therefore, solicited, and suggestions are invited. These investigations, however, indicate that some establishments can probably make a considerable saving in this item,—enough out of the small number so far compiled to more than pay the whole expense of this investigation, if they are thereby brought to the standard indicated by the fairly economical plants.

"Further data are needed on this subject. For instance, we find that in nearly every one of the hard-coal plants of which we have data the amount of coal per man is about the same as in soft-coal plants under corresponding conditions as to load, etc., but the rate of wages is higher, making the cost per ton higher for the hard coal. It is, therefore, impossible as yet to tell whether this is because men have to be paid higher wages to handle hard coal, or whether these men would insist on the same wages and handle no more soft coal than they do hard. The location of the plant does not, so far, appear to explain this difference of wages.

"Several plants running under different conditions, but obtaining about average results, have been selected, and their figures are placed directly opposite the headings as a guide in filling out the columns, and also as examples of what seems to be fair, but not necessarily the best, practice under their conditions.

"Reliable data are especially desired from plants using mechanical stokers, shaking and damping grates, and downdraft furnaces. Records from the same plant in successive years under the same conditions are also desired. In plants where special coal-handling devices are used, data as to cost of installing, repairing, and operating are desired, so that the effect on the cost of firing may be directly studied."

Wax for Holding Work on Grinder.

When we recall that for a long period wax has been used by opticians and lapidaries for firmly holding small pieces to be ground, it seems strange that it should not have sooner and more widely occurred to machinists that this method could be extended to much of the grinding-work now done in machine shops. A correspondent of *American Machinist* (April 30) writes that the method is used with great satisfaction in an establishment requiring the grinding of a quantity of small work on Browne & Sharpe surface grinders. The work in question is all hardened, and, of course, is more or less sprung in the process. In grinding this work true after hardening, the springing of the work again during the grinding is prevented by the use of wax as a holding-cement, by which all points of the piece operated upon are held with equal tension to, and supported with equal rigidity upon, a platen or holder. In clamping work for grinding, it is in many cases impossible to hold pieces without springing,—especially if the piece be

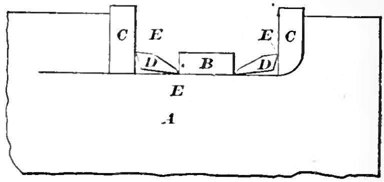


Fig. 1

flat and thin, and must be held by pressure against its edges. More or less buckling is apt to come in in such cases, and, when the piece is ground flat on the holder, it is, when released, no longer flat. With wax used as described, a piece ground flat on the platen is flat when taken off, and, if

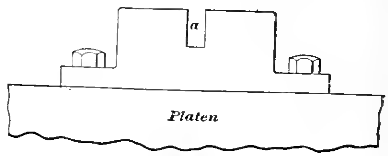


Fig. 2

the opposite sides are required to be parallel, this is probably the very best way in which such a job can be executed.

The correspondent referred to (who signs "Theo") says that, in the factory from which he writes, they "lay the work down on the platen, perfectly free, and then pour hot wax around it. For winter

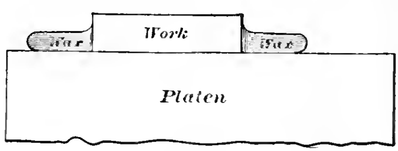


Fig. 3

we use about three parts of common beeswax to two parts of rosin. It will be necessary to use a slightly greater proportion of rosin for summer. This wax is used almost entirely for grinding parallel work. It holds very firmly, the work rarely, if ever, coming loose; and, as benzine cuts the wax off from the pieces after they come from the machine, and from the machine platen, it is very little trouble. A pan of benzine is kept at hand to soak the pieces in. The wax will also hold work sufficiently strong on a planing-machine or lathe face plate, if the cuts are light, and it has the advantage of turning out the work as true as the machine itself, and not depending on vises or fixtures which may not be in the best shape.

"Work may be held very well and with good results, as shown in Fig. 1, in which *A* is the vise and *B* the work which is held between the jaws, *C C*, by the strips or ribs, *D D*, bearing at the points, *E E E E*, and tending to hold the work firmly on the base of the vise or fixture. This method has been in use a good many years; but the wax has the advantage of a clear surface over the work, however thin it may be, which prevents any liability of running the tool or emery wheel into the holding device.

"Another very important point is that, when there are a number of pieces to be worked all alike, they may all be put on the platen at the same time, or, at least, it may be covered with the pieces, with only a small space between for wax. It is only necessary to take one off occasionally to caliper, and it may be put back again without trouble. Oftentimes the work is of such nature that it may be put over a T-slot, and so may be measured without removing it from its place. We frequently use a block (Fig. 2) to hold the work, which also admits of measurements without removing the work from its place, the slot, *a*, being large enough to admit the base or anvil of a micrometer caliper.

"I am well aware that the wax method has long been used by instrument-makers on the face plates of small lathes, but think its application to grinding machine is new.

"A convenient thing for holding the wax and melting it is an ordinary pressed-tin cup with a spout put in the side. A piece of cotton string laid in the V of the spout, and hanging outside about ¼ inch, will prevent the wax from running down the outside of the cup, and will enable the operator to direct the drops in exactly the right spot. If the cup is held about three inches above the work, the wax will come up pretty high at the edge where it falls, as shown at Fig. 3, and is best, where the size of the work will admit; but for very thin pieces the cup must be held up twelve or fourteen inches, when the wax will flatten out as it strikes the platen, and will not stand up above the work and have to be pared down, as it would, if the cup were not so held. An ordinary gas jet burning up about ½-inch will keep the wax at about the proper temperature all the time."

We are inclined to believe that this method must have been more widely used than is implied in "Theo's" communication; but the practical hints given upon the mode of applying wax to the purpose of holding small pieces are worth "pushing along."

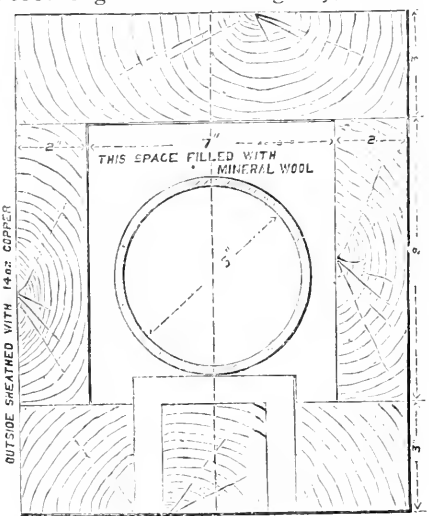
Insulating Underground Steam Pipes.

THE insulation of underground steam pipes has always been a matter of difficulty. Many plans have been adopted, a large majority of which have been, to say the least, only moderately successful, while many have totally failed to serve even passably well the purpose intended. If it were possible and practicable to keep the insulating material dry underground, the principal difficulty would be removed. Water infiltrating any porous substance and reaching the surface of a steam pipe insulated by such material destroys its efficiency at once; and practically all good heat-insulating materials are porous. In fact, some eminent authorities have maintained that most of the materials in use for steam-pipe insulation are good for this purpose merely because they inclose a multitude of minute air-spaces, the air confined in these spaces being the effective insulating agent.

The cracking of wood, as ordinarily used for underground pipe insulation, is a serious objection to it.

In *The Engineer* (April 10) Mr. Edgar Kidwell of the Michigan Mining School, Houghton, Mich., presents a method for preventing loss of heat, which seems almost good enough to protect a pipe which has to pass through a body of water. He states that he has used this method with success under very unfavorable conditions. We herewith reproduce the cuts accompanying Mr. Kidwell's description, which follows:

"To meet these conditions I designed the conduit as in Fig. 1. The lumber was all edged and quite dry. A trough was built in 14-foot sections, with halved joints 1 foot long. To insure rigidity, the bot-



CAST IRON BEARING BLOCK
FIG 1
SECTION THROUGH CASING

tom joints were located 2 feet from those in the side, and all the joints were firmly screwed together, after the conduit was lined up. It has been my experience that, in cases like this, roller-bearings are of little account, since we have no guarantee that they will operate after the pipe has been in use for some time, and the roller journals have become rusted, or stick from the gumming of the oil. I therefore discarded rollers, and placed under each pipe-coupling a cast-iron chair (Fig. 2), which is faced on top, and allows the pipe to slide easily. This plan has been used for years by one concern which employs many hundred feet of 12-inch pipe carrying steam up to 160 pounds, and in no case has trouble developed.

"To insure tightness, the following plan was adopted: makers of planished copper can supply sheets which are slightly defective in the tinning, and have to be sold as scrap. We purchased sheets of this copper, 14-oz. and 16-oz. weights, in widths of 11 inches and 41 inches, riveted and soldered similar widths end to end, then turned up the broad width into a trough 11⅛ inches wide. This was first put into the trench, the wooden trough was then lowered into it, the work was then lined up, the pipe was next laid, and then the trough was filled to the top with mineral wool loosely packed in place. The wooden cover was then secured with 5-inch screws, the 11-inch copper was next rolled along the cover, and the joints along the top edges of conduit were then carefully soldered. The metal covering was carried through the walls of the buildings at each

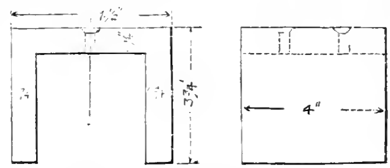


FIG 2
BEARING BLOCK UNDER COUPLINGS
FACED ON TOP

end of the pipe line, and pieces of copper soldered to the casing were flushed into the outside face of the walls.

"To guard against any chance of the pipe getting out of line by reason of decay of the wood, the chairs were provided with two lugs (Fig. 2), which passed clear through the bottom plank and rested directly on the copper, and beneath the latter a large flat stone was carefully bedded into the earth. The chairs were secured to the plank to prevent any motion and the consequent wear on the copper. Where fills were encountered, care was taken to put a bearing stone and cast chair on each side of it, so that any deflection of the conduit could not affect the pipe. The soil was very gravelly, so that no under-drainage was provided, and it is questionable whether such drainage would ever be necessary with a conduit like this. A conduit like this can stand a great deal of distortion without any harm. As to its insulating qualities, I may say that it has been in use several years, has given perfect satisfaction, and at no time is there any external evidence that the pipe line exists. I have never been able to detect any escape of heat through melting of snow over the trench. Cost of the work was as follows. Cost of pipe and laying mineral wool, and excavating trench are not included, as they form no part of the conduit proper.

Length of conduit.............. ....142 ft.	
	Dols.
Copper smith, 2¼ days, at 4.00 dols....	9.00
Steam fitter—lining up—1¼ days, at 4.00 dols........................	5.00
Three laborers, 1¼ days, at 1.50 dols....	5.63
Carpenter, 9 days, at 3.00 dols..........	27.00
Solder, copper tacks, and rivets.........	2.20
4 grs. 5 in. No. 20 wood screws...	5.72
1 grs. 2 in. No. 14 " "	.66
1350 ft. white pine at 17 per m.........	22.95
520 lb. tinned copper scrap at .11	57.20
135 lb. castings at .03½...............	4.73
Carting....	1.50
Total..............	141.59

Or about 1 dol. per lineal foot. No charges are made for stone-bearing plates or for planing chairs. Lathe work was done in our shops by students. We had left from a new building some stone which we had no other use for, and were glad to get rid of it by putting it under the conduit.

"Mr. Carpenter describes a conduit consisting of a tile pipe placed inside a wooden casing. To me this seems a wholly mistaken construction. As the wood shrinks and swells, it will loosen the joints in the tile. The wood will also absorb water, and be of little use as a heat insulator. It would have been better, I think, to have used a large tile and put the wood casing inside of it. If the tile is properly laid on a sand or gravel foundation and fills are carefully looked after, it can be kept tight, so that the wooden casing will be dry and of some use as a heat insulator.

"The conduit permits the pipe to be got at easily. A few minutes' application of the blast lamp is all that is needed to open up the sheathing, and, as the screws were dipped in lard and plumbago before driving, they can be easily drawn. If no provision is to be made for opening the conduit, it seems to me that the best form of casing is galvanized spiral-riveted or welded pipe, with proper chairs for the steam main to slide on."

Conductivity of Boiler Scale.

THE following is an abstract of an article in *Power* for May. The experiments described were instituted as a result of a statement made by several members at a recent meeting of Columbus Association No. 31 N. A. S. E. of Brooklyn. These engineers said that during their experience they had noticed cases in which boilers were incrusted to a thickness of upwards of one-quarter of an inch, and yet the economy was not affected appreciably. The results of the experiments are thought to prove that the relative conductivities of iron and scale are very improperly applied, when used as a basis upon which boiler economy is reckoned, especially in a properly-designed boiler. In many books on steam engineering can be found statements to the effect that one-sixteenth of an inch of scale will cause a loss of fully fifteen per cent. of fuel, one-eighth will cause a loss of thirty per cent., and that one-fourth will bring the loss up to fifty per cent.

This statement is so broadly made as to justify the inference that the authors mean to imply that the loss will be in the proportions named, in any type of boiler, or in any ratio of grate to surface. Neither is there any exception made regarding the kind of scale, which differs materially in composition in different localities and with the qualities of different feed-waters. The experiments were made with apparatus designed and constructed by the educational committee, Jos. P. Clark, Neil McEwen, and Frank J. Wood, and consisted of the several pieces shown in the drawings.

Fig. 1 is for the purpose of determining the relative conductivity of materials, such as iron, scale, cement, etc., and consists of a small gas stove on which is placed the vessel of water A. After the water is boiling, the cover B, at a signal from a timekeeper, is dropped quickly on the vessel. Through this cover are holes about one inch square, over which are fitted the samples of material to be tested. There are pieces—one of each—of brass, iron, boiler scale, plaster of Paris, and Portland cement. Stuck with wax to the top of these samples, at an angle of about forty-five degrees, are short pieces of wire. After dropping the cover on the water vessel, the steam heats the samples, and, after the heat penetrates to the wax, the pieces of wire drop. It is obvious that this dropping will be about in the order of the conductivities of the different samples.

Fig. 2 is a cover to be used in the same manner as the one above described, but

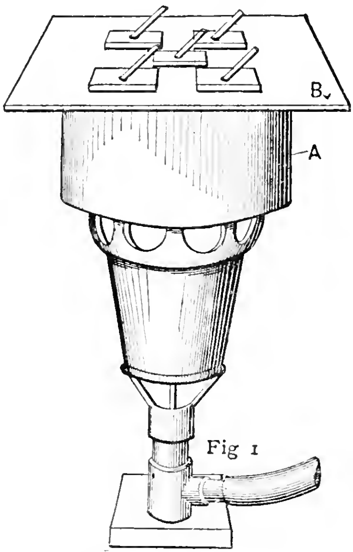


Fig 1

there is a different arrangement of samples. The cover itself is of sheet-brass 1-32 of an inch thick; one square inch of the top is coated over with a sample of plaster of Paris 3-32 thick; another square inch is covered with a 1-4- inch coating of Portland cement. There is a piece of wire stuck

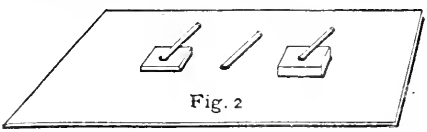


Fig. 2

with wax on the sample of cement, another on the plaster of Paris. and another directly on the brass plate. Figs. 3 and 4 are views of an apparatus for testing the heating efficiency of clean and coated tubes. A small sheet-iron furnace A is heated by a small gas stove or Bunsen burner; on top of the furnace stands the vessel of water B. This vessel is about 1¾ inches in diameter and about 25 inches long. In the interior of this cylinder is a tube extending through the bottom of the cylinder into the top of the furnace and 1-32 of an inch thick and about 5-8 of an inch outside diameter, reaching from about one inch below the bottom end to a little above the top end of the cylinder. The ratio of the diameter to the length of this tube is about the same as that in ordinary boiler tubes.

There were several of these cylinders made; the dimensions and weight of the metallic parts were similar in every respect. Two of these vessels were left clean, but in one there was 3-32 of an inch of plaster of Paris coated on the tube, in the same way in which scale coats a boiler tube; in another vessel 1-4 of an inch of Portland cement was coated on the tube. The tendency of the heated gases from the flame will be to go through the tube in the vessel of water, but, as the capacity of this tube is not great enough to carry off all the gas, some must make its exit by coming down between the outside and inside casings of the furnace and flowing out through the chimney, C.

This chimney carries the surplus of heated products to such a distance from the vessel of water that there is no chance for the outside of the water vessel to act as a heating surface by receiving heat from rising hot gases. In the top of the furnace and directly under the tube is a pyrometer, P, which, though not indicating the degrees, serves to indicate changes in the temperature at the top of the furnace. This pyrometer is made of a small strip of brass riveted to a similar strip of iron, one end being secured to the side of the furnace, while the other is connected by a wire to a pointer that moves over a graduated scale. Unequal expansion of the brass and iron bends the riveted strips, the pointer indicating temperature. In the water at the top of the vessel is placed a thermometer.

In the first experiment (Fig. 1) the water was made to boil briskly, and, at a signal from a timekeeper, the cover was quickly placed on top. The pieces of wire dropped in the following order: brass, 5 seconds; iron, 9 seconds; plaster of Paris, 35 seconds; Portland cement, 63 seconds; scale (Ridgewood water, Brooklyn), 35 seconds. In the experiment with the cover shown in Fig. 2 the object was to show the relative conductivities of the heating surfaces just as they are in the different water vessels. In this experiment the pieces of wire dropped as follows: brass, 4 seconds; plaster of Paris, 26 seconds; Portland cement, 71 seconds.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

The Machine Shop.

5580. Trolley Systems. H. M. Ramp (The uses and advantages of overhead trolley systems in foundries, and the economy of labor and time effected by them). Foundry-April. 2500 w.

5583. Plumbago Facing. John A. Walker (Reasons why plumbago makes the best facing for sand molds, are found in the physical character of this form of carbon). Foundry-April. 600 w.

5584. Does the Blast Meter Tell the Truth? H. Hansen (Reasons why a speed indicator may probably furnish more reliable indications with reference to a blast for a cupola, than a blast meter). Foundry-April. 1200 w.

5585. Management of Cupolas. E. Grindrod (Holds that there is no chance work in casting when a cupola is properly charged, and gives practical directions for proper charging). Foundry-April. 700 w.

5690. Bed and Cylinder Tools—"Straight Line" Engine Shop, Syracuse. Herman Landro (Illustrated description both of shop and tools employed in the manufacture of the "straight line" engine). Am Mach-April 30. 2000 w.

5692. Wax for Holding Work on Grinder—A Milling Machine Difficulty. Theo (This paper illustrates and describes some very useful shop "wrinkles"). Am Mach-April 30. 700 w.

5756. Laying Out Belting. Thomas Hawley (To drive shafting in various positions. Illustrated description of the various ways in which belting is applied in use and methods of laying out work in their application are presented). Bos Jour of Com-May 2. 2200 w.

5760. Pattern for Gusset Sheet for Locomotive Jacket (Answer to correspondent giving full explanation of method). Met Work-May 2. 1000 w.

5897. Power Required for Driving a Pipe-Threading Machine, a Boring Bar and a Roll-Turning Lathe. J. S. Cox (A record of tests of pipe threading machines made to ascertain the power required for cutting off, and for cutting threads on different sizes of pipes). Am Mach-May 7. 250 w.

Steam Engineering.

*5268. Points in the Selection of Steam Engines. W. H. Wakeman (Showing the factors that enter into a steam engine's usefulness, and the considerations that should govern purchasers). Eng Mag-May. 3900 w.

5364. Efficiencies of Boilers. John C. McMynn (In this paper the author strenuously urges distinctions between efficiency of a boiler, efficiency of a furnace, and efficiency of boiler and furnace considered together, and holds that the separation of the efficiency of furnace, apart from that of the boiler, is a problem demanding solution. He makes however no attempt to solve it). Elec Engng-April. 1300 w.

5480. Economical Equipment and Operating of Power House. H. S. Newton (Paper read before the New York State Railway Assn. Contains valuable suggestions for stationary engineers). Lord's Mag-April. 1800 w.

*5561. Measurement of Feed and Circulating Water, etc., by Chemical Means. C. E. Stromeyer (An ingenious application of the known solubilities of substances in water, to boiler feed measurement, and to the determination of the quantity of water entrained in steam. Read at the 37th Session of the Inst. of Naval Archs.) Eng, Lond-April 10. 3500 w.

5625. A Fly Wheel Built of Steel Plates (Illustrated detailed description. The fly-wheel is also designed for a belt wheel). Eng News-April 23. 400 w.

5693. Triple-Expansion Engine for Direct Connected Electric Generator (Illustrated description with full details of an entirely new valve motion called "pouse-gear," a most ingenious device, with which the intermediate pressure valves are fitted). Am Mach-April 30. 2300 w.

5724. How to Find the Point of Cut-off (Mathematical and graphic methods both given, and the superiority of the graphic demonstrated). Power-May. 900 w.

5725. The Conductivity of Boiler Scale (Experimental determinations with different materials by Jos. P. Clark, Neil McEwen, and Frank J. Wood, of Columbus Assn., No. 31, N. A. S. E. of Brooklyn, N. Y., with illustrated description of apparatus and methods). Power-May. 1500 w.

*5728. The Relative Importance of the Wastes in a Steam Engine. Arthur L. Rice (Computations undertaken in an investigation of the subject of initial condensation from standpoints of both theory and experiment). Sib Jour of Engng-April. 2200 w.

5775. Efficiency of Boilers and Engines. Thomas F. Scheffler, Jr. (Regarding the time as not far distant when the efficiency of boilers will be calculated from the total number of British thermal units, the author proceeds to discuss a method of determining boiler efficiency on this basis). Mach–May. Serial. 1st part. 1800 w.

*5800. Phillips Water-Tube Boiler (Illustrated detailed description). Engng–April 24. 450 w.

5847. Nova Scotia Coals as Steam Producers. F. H. Mason and W. G. Matheson (The object of the paper is to place on record some results obtained from an analysis of samples of coal from the various mines in Nova Scotia. This is entirely as regards coal as fuel as being capable of evolving so much heat. With its properties as a gas producer, or its value for coking it has nothing to say). Can Min Rev–April. 2200 w.

5872. The Evolution of the "High-Speed" Engine. R. H. Thurston (A comparison of low, moderate and high-speed engines, a statement of the advantages and disadvantages, with copious tabulated data and diagrams. Concludes with an illustrated description of a high-speed quadruple-expansion engine, designed by Messrs. Hall and Treat at Sibley College, and tested in the shops of the institution, which the author states, gives a horse-power with a consumption of less than ten pounds of steam). Elec–May 6. 5400 w.

†5874. Determining Moisture in Coal. B. S. Hale (Read before the A. S. M. E. An account of work done for the Steam Users' Assn. of Boston, and of methods employed in the quantitative determination of moisture in coal). Trans Am Inst of Mech Engs–Vol XVII. 3000 w.

†5876. The Effect, upon the Diagrams, of Long Pipe-Connections for Steam-Engine Indicators. W. F. M. Goss (Read before the A. S. M. E. An experimental investigation of this subject is given with illustrated description of means and methods employed, steam indicator diagrams showing effect of connections and conclusions). Trans Am Inst of Mech Engs–Vol XVII. 3300 w.

†5877. Experiments with Automatic Mechanical Stokers. J. M. Whitham (Read before A. S. M. E. Mechanical stoking and stokers are discussed and their advantages stated, and experimental data, from tests of several kinds, are tabulated). Trans Am Inst of Mech Engs-Vol XVII. 3800 w.

†5878. New Form of Steam Calorimeter. R. C. Carpenter (Read before the A. S. M. E. Illustrated detailed description of a calorimeter in use in Sibley College, for about one year, and of the proper method of using it). Trans Am Inst of Mech Engs-Vol XVII. 1800 w.

†5880. Test of a Four-Cylinder Triple-Expansion Engine and Boilers. A. H. Eldredge (Read before the A. S. M. E. Illustrations of plant indicator diagrams and very full data are presented, the latter in tabulated form). Trans Am Inst Mech Engs-Vol XVII. 1400 w.

†5881. The Effect of Retarders in Fire Tubes of Steam Boilers. Jay M. Whitham (Read before the A. S. M. E. Data obtained from tests of a 100 horse-power tubular boiler, with conclusions favorable to the use of retarders, especially in tubular marine boilers). Trans Am Inst of Mech Engs–Vol XVII. 1300 w.

†5882. A Self-Cooling Condenser. Louis R. Alberger (Read before the A. S. M. E. Describes and illustrates a practical condensing apparatus for use with steam engines, operating without natural water supply and giving results claimed to compare most favorably with those obtained by ordinary condensers). Trans Am Inst of Mech Engs–Vol XVII. 4800 w.

†5883. Superheated Steam. R. H. Thurston (Read before the A. S. M. E. Facts, data, and principles relating to the problem. The subject is broadly treated in all its aspects, with formulæ and diagrams, and illustrations of some forms of superheaters). Trans Am Inst of Mech Engs–Vol XVII. 22000 w.

†5589. The Efficiency of a Steam Boiler. What Is It? William Kent (Read before the A. S. M. E. A defense of the desirability of still using the "pound of combustible" as a basis for the estimation of boiler efficiency, in comparison of different tests). Trans Am Inst of Mech Engs–Vol XVII. 3800 w.

5900. The Action of Fluorides on Feed Water and Corrosion in Steam Boilers. A. Wangemann (A paper read before Robt. Fulton Assn. of stationary engineers. The use of sodium fluoride has hitherto been obstructed by its cost. The writer states that the price has now been reduced and that it is available. Its advantages and practical points in use for preventing scale in boilers, form a very useful paper). Sta Eng–May. 4000 w.

Miscellany.

*5289. The Mechanical Transmission of Power. W. E. Buck (Contains little that is new. The first part is a fairly good review of general practice, so far as possible to carry the discussion. Other succeeding parts will doubtless cover the remaining ground). Mech Wld–April 3. Serial. 1st part. 2400 w.

5326. New Rules for Testing Boiler Plates (A sharp editorial criticism of the new rules of the Board of Inspectors of Steam Vessels so far as they relate to testing plates for use in steam boilers). Eng News–April 9. 1100 w.

5330. The New Rolling Mill of the Pittsburgh Reduction Co., New Kensington, Pa. (Description of a 2-high rolling mill for manufacturing aluminum plates). Eng News–April 9. 1100 w.

5356. Proposed Patent Legislation (Editorial review of bill No. 3014, in the House of Representatives comprising amendments of the present U. S. patent laws). Sci Am–April 18. 1500 w.

5360. Licensing Engineers. W. H. Wakeman (An argument in favor of licensing engineers to operate steam plants, which however admits that there are some good grounds for opposing the system). Safety V–April. 3000 w.

*5399. A New Transmission Dynamometer. S. W. Robinson (Illustrated detailed description with explanation of its application and method of showing corrected results). Digest of Phys Tests–April. 2800 w.

†5409. Circular Wheel-Teeth. Archibald Sharp (The treatment is severely mathematical. The author, having previously described a

method of drawing circular wheel-teeth having a very small variation in their angular velocity-ratio, investigates the problem in a more general manner in this series of articles). Ind & East Eng-March 21. Serial. 1st part. 3000 w.

*5414. The Development of the Milling Machine. Samuel Dixon (Paper read before the Manchester Association of Engineers. Treats of the principles underlying construction, adaptations to different kinds of work, general usefulness, and the rapid increase of its use in modern shops). Col Guard-April 2. 3000 w.

5472. A Simple Derivation of the Formula for the Strength of Beams. Walter Ferris (A very successful attempt to explain the derivation of the formula, without the use of calculus, which explanation. though somewhat more cumbrous than is given by the calculus, is yet quite easily followed by those who can handle simple algebraic equations of the first degree). Am Mach-April 16. 1500 w.

5473. Test of a Compound Air Compressor (Gives data and a computation of saving effected, with some general remarks upon stage compression, as compared with single compression. Review of a graduate thesis prepared by F. C. Weber and W. K. Lanman, at Cornell University). Am Mach-April 16. 1000 w.

5474. A Compressed Air Paradox. Frank Richards (Effect of velocity upon friction of air in pipes is well discussed and a formula for computing the head for forcing air through pipes at different velocities is given). Am Mach-April 16. 900 w.

5489. High-Pressure Air Compressors of the Pneumatic Gun Battery at Fort Winfield Scott. San Francisco, Cal. B. C. Batcheller (Illustrated description with data. An instructive article). Am Mach-April 23. 1800 w.

5490. Uses and Advantages of a Public Supply of Compressed Air for Elevators Frank Richards (The use of compressed air for elevators in buildings, with diagrams of pressure in air cylinders of stage compression machines, and a statement of conditions under which it may be substituted for the hydraulic system are the main features). Am Mach-April 23. 1100 w.

5577. Iron Foundry Buildings. O. Benson (Construction of roofs with reference to the use of powerful cranes, and of foundries, with reference to reducing fire risks, and cost of insurance, etc). Foundry-April. 1200 w.

5578. The Growth of Foundry Literature. Thomas D. West (Mr. West takes a leaf from his personal experience as a writer for technical papers, and reviews the general effect of foundry literature upon the art of founding). Foundry-April. 2000 w.

5579. Money Saving Devices in the Foundry. E. H. Putnam (Describes a sweep and its use in making a mold of a form illustrated. The sweep is also illustrated). Foundry-April. 650 w.

5581. Impressions Upon Cast Iron Surfaces From Lace, Embroideries, Fern Leaves, Etc. W. J. Keep (Gives full description of the way these impressions may be produced, and illustrates in half-tone engravings the effects so obtained). Foundry-April. 1600 w.

5582. The Effect of Atmospheric Temperature and Humidity on Melting Iron in a Cupola. A. Sorge, Jr. (Maintains that atmospheric humidity is an important factor in melting iron and pouring it into molds, and explains how adverse effects are produced by it). Foundry-April. 600 w.

5624. A New Dynamometer for Measuring Power Absorbed in Driving Machinery (Illustrated detailed description of a transmission dynamometer, claiming to be an improvement on an instrument built by Prof. S. W. Robinson of the Ohio State University for use in the mechanical laboratory of that institution). Eng News-April 23. 700 w.

*5664. The Economical Use of Blast-Furnace Gases. A. S. Keith (Abstract of paper read at the Cleveland Institution of Engineers, England, with short discussion). Ir & Coal Trs Rev-April 17. 2500 w.

*5667. On the Development of the Milling Machine for Heavy Engineering Work. Samuel Dixon (The object is to review in some measure the rapid development of milling which has taken place in recent years in all the best engineering workshops, and to point out the broad lines upon which the development is taking place). Ind & Ir-April 17. 5800 w.

*5671. "The Engineer" 1100 Guinea Road-Carriage Competition (The full conditions of this competition are given, with classification, names of judges, and directions for those who desire to compete, and blank form of agreement, to which competitors must subscribe. The Crystal Palace will be the center from which vehicles will start, which affords facilities for minor trials, and all the publicity which can be desired. The conditions however are only to be valid in case the new act of parliament, now introduced, removes some existing restrictions. The date of the competition is not yet named). Eng, Lond-April 17. 3000 w.

5678. The Kitson Gas Producer (Illustrated detailed description with favorable report of engineer John E. Fry, of Pittsburg, upon the merits of the invention. In this gas-producer the fuel is kept constantly agitated, which agitation is claimed to prevent caking, clinkering and scaffolding of the fuel in the furnace). Ir Age-April 30. 2400 w.

5679. Automatic Feed Device for Gas Producers. C. W. Bildt (Translation from *Jernkontoret's Annaler*, illustrating and describing a new device constructed for the Stridsberg & Bjoerks Works at Trollhattan, Sweden). Ir Age-April 30. 1800 w.

*5726. The Engineering Experiment Station of Sibley College, at Cornell University. R. H. Thurston (Description of the organization of this experiment station, the work carried on therein, its outfit and methods, closing with a plea for further means to extend its usefulness). Sib Jour of Engng-April. 7500 w.

*5729. Carpenter's Viscosimeter. O. Shautz (Illustrated description of a new instrument for testing the "viscosity" of lubricants). Sib Jour of Engng-April. 700 w.

†5738. Some Fuel Problems. Joseph D. Weeks (The Fuel Problem is to reduce the waste and increase the efficiency of the coal we possess. The question is considered under the divisions of (1) the mining of coal and its preparation for market; (2) the use of coal; (3) the products of the coal other than heat). Trans Am Inst of Min Eng–April. 4500 w.

†5740. Notes on Conveying-Belts and Their Use. Thomas Robins, Jr. (Experiments and tests of rubber belting to ascertain what particular compound of rubber would make the most durable carrying-surface. Also, illustrated description of methods of supporting conveying belts, study of proper width for duty to be performed, etc). Trans Am Inst of Min Eng–April. 4000 w.

†5743. On the Determination of the Division Errors of a Straight Scale. Harold Jacoby (Gill's method, an improvement on Hansen's and Lorentzen's formula are both explained and discussed. A modification of Gill's method, by the author, follows, whereby acccuracy within $\frac{1}{50000}$ inch is obtained, and the non-periodic errors of a screw are determined without assumption of any law of error). Am Jour of Sci–May. 3400 w.

5774. Magnesium as a Constructive Material. R. H. Thurston (The author regards magnesium as a possible rival of aluminum in alloys for use in the arts, and gives reasons for this opinion). Mach–May. 2700 w.

5776. How to Select a Slide Rule. William Cox (As indicated by the title this is a practical article designed to aid in and extend the use of the slide-rule in mechanical and other computations). Mach–May. 800 w.

5777. Strength of Hydraulic Cylinders. Juan de D. Tejada (General discussion with rules for calculation). Mach–May. 1700.

*5804. The Strength of Cylindrical Shells. F. Keelhoff (Contribution to a subject recently much discussed in *Engineering*. Mathematical in character). Engng–April 24. 600 w.

5836. The Power Plant at Pelzer, S. C. (Illustrated detailed description of one of the most interesting and important water-power developments in the South). Eng Rec–May 2. 2200 w.

*5843. Horse Power of Windmills (General discussion with a half-tone illustration of a flour mill in Holland operated by wind power). Am Miller–May 1. 400 w.

†5873. A Study of the Proper Method of Determining the Strength of Pump Cylinders. Charles W. Kettell (Read before the Am. Soc. of Mech. Engs. A method of analysis for the determination of the stresses in long horizontal pump cylinders, usually made with an upper and lower valve deck). Trans Am Soc Mech Eng–Vol XVII. 2200 w.

†5875. Spring Tables. G. R. Henderson (Tabulated data for determining the various properties of a helical or elliptical spring, and considered preferable to diagrams on logarithmic cross-section paper, presented by the same author at the Dec. 1894 meeting. Read before the A. S. M. E.). Trans Am Inst of Mech Engs–Vol XVII. 2000 w.

†5879. A Hydraulic Dynamometer. James D. Hoffman (Read before the A. S. M. E. Illustrated detailed description of this machine, constructed at Purdue University for the purpose of tests on the application of cutting edges to iron). Trans Am Inst of Mech Engs–Vol XVII. 1000 w.

†5884. Structural Steel Fly-Wheels. Thomas. E. Murray (Read before the A. S. M. E. Deals with methods for constructing fly-wheels which will not be liable to burst, and takes the ground that the use of cast-iron for this purpose has reached its limit. Structural wheels of steel are advocated and an example of the construction of such a wheel is illustrated and described). Trans Am Inst of Min Engs–Vol XVII. 1400 w.

†5885. Topical Discussions and Notes of Experience. William Sangster, W. F. M. Goss and John H. Cooper (Read before the A. S. M. E. Topics discussed were clamp-fits, power to drive disk fans, effect of fire on machinery, and how to locate a steam-engine condenser. Further elucidation of these subjects was requested). Trans Am Inst of Mech Engs–Vol XVII. 1400 w.

†5888. Hollow Steel Forgings. H. F. J. Porter (Read before the A. S. M. E. Describes and illustrates a method of forging hollow shafts or rolls, and gives substantial reasons for adopting it. Formulæ for twisting moments, etc., of such forgings are given, and some accounts of notable forgings of this kind are presented). Trans Am Inst of Mech Engs–Vol XVII. 2800 w.

†5892. Water Renaissance. John Birkinbine (The author reviews the recent large increase of the use of water-power in the industries of the world, resulting from the electrical distribution of power from power stations located on streams, and discusses a possible farther increase to meet the demands of power for irrigation. Incidentally some remarks are made on the water supply of cities). Pro Eng's Club of Phila–April. 3000 w.

5893. The Uses and Advantages of a Public Supply of Compressed Air for Pumping or Raising Water. Frank Richards (It is pointed out that a pump could be made exactly proportionate for this purpose, and that compressed air in a well designed pump may be economically used for pumping. Considerations which should influence design follow). Am Mach–May 7. 1800 w.

5894. Some Dividing Tools. A. H. Cleaves (Illustrates and describes a number of methods of doing different kinds of dividing work). Am Mach–May 7. 800 w.

5910. The Transmission of Power by Wire Ropes. William Hewitt (This paper presents new formulæ and tabulated results differing from those hitherto used, based on the fact that the bending of wire laid in rope around a sheave gives a less resistance than the bending of straight wire of the same size around a sheave of the same size, as previous writers have assumed). Eng News–May 7. 1200 w.

MINING & METALLURGY

Lessening the Danger of Blasting in Fiery Pits.

THE principal danger in blasting in gaseous mines, or coal mines containing much dust, lies in the fact that such gases or dust are liable to ignition from the flame of the explosive or fuse used, which would produce a disastrous explosion in the mine. Speaking of this matter, the *Colliery Guardian* (Mar. 6) quotes from an article by Mr. Franz Brzezowski in the *Oesterreichische Zeitschrift für Bergund Hüttenwesen*, as follows:

"There are now several reliable systems of central-fire cartridges in existence, such as the electrical fuses (high tension, or quantity—the latter for choice, as offering less danger of igniting the gas by sparking); Tirmann's percussion detonator, which, out of 400,000 shots, only gave 0.2 per cent. of miss-fires; the improved Lauer friction fuse; and the Jaroljmek water-cartridge.

"Von Lauer's experiments go to prove that the disruptive power, and, therefore, the danger, of an explosive is modified by the strength of detonator employed, and it has been found with the Trauzl method the volume of gas evolved from 15 grains of explosive varied with the detonator as follows:

	Detonator Cap.			
	1 grm.	2 grms.	3 grms.	
Wetterdynamit.	350	356	—	cubic meters.
Westfalit......	350	546	618	"
Progressit	354	566	590	"
Ferifractor	—	560	—	"

"The decrease of security resulting from the use of large detonators may be gathered from the fact that a blown-out shot of 500 grams of westfalit fired by a 1-gram detonator did not explode a 7 per cent. mixture of firedamp, whilst 300 grams ignited by a 3-gram cap under similar conditions did. It is, therefore, evident that the term 'safety,' as applied to these explosives, is only relative.

"Concerning the constitution of the explosives suitable for fiery pits, 'safety explosives,' with the exception of 'wetter'-dynamite (a mixture of dynamite and crystal soda), mostly consist of ammonium nitrate (up to 96 per cent.), mixed with aromatic hydrocarbon compounds (benzol, naphthalin, anilin) or their nitro-compounds, resins or fats, and can only be fired by powerful detonators, their safety depending on the smallness of the flame produced. These substances are completely harmless in themselves, being proof against shock or flame, and can be handled with red-hot iron tongs or exposed to the flame of the oxyhydrogen blow-pipe without exploding, merely fusing ard burning with a small flame, and ceasing to burn when removed from the fire. These properties are valuable for mining purposes, as none of these preparations give deflagrating shots. 'Wetter'-dynamite will deflagrate if the detonator is insufficiently powerful, but the others under consideration simply refuse to explode, under similar conditions, and they have the further advantage over dynamite of not freezing except at very low temperatures,—seldom, therefore, requiring to be thawed out. In fact, they can only be fired by means of very powerful caps, and, the closer they are compressed, the stronger will the cap have to be. When of a density of 1.6 to 1.7, a 2-gram cap or dynamite fuse is insufficient.

"The most convenient density is 0.8. The dispersive power increases, and the security decreases, with the proportion of hydrocarbon compounds, and with the strength of detonator employed. Ammonium oxalate or the salts of chlorine, bromine, and iodine diminish the efficiency but heighten the safety, of these explosives. On the other hand, amongst the disadvantages may be noted their low density—which necessitates wider boreholes—and especially their hygroscopic power, which, however, may be counteracted by careful packing.

"The value of 'safety explosives' may be judged from the following experiments with 'progressit,' a preparation which for security is found to be surpassed by none:

150 grams of progressit could not be exploded by a 2-gram cap, when lying free in a mixture containing 2 per cent. of gas and 3 kilos. of coaldust, whereas 300 grams of No. 1 dynamite exploded with violence; 150 grams of progressit lying free in presence of 10 per cent. of gas and 3 kilos. of coaldust were exploded by a 1-gram cap, but failed to ignite the mixture in any of the ten tests applied, and in only two out of four cases did a 2-gram cap explode the mixture; 400 grams of progressit lying free in a mixture containing 7 per cent. of gas and 3 kilos. of coaldust and fired with a 2-gram cap did not produce ignition.

"The means at present at disposal for combating the danger of exploding fire-damp in blasting are briefly: the central-fire cartridge; moss stemming; good quality paper for covering the cartridges; safety explosives (up to the maximum charge of each); removal of suspended coaldust by spraying; and, finally, the entrusting of the operations to a skilled workman."

Another Impending Gold Boom.

According to *Machinery* "special attention is now being directed to New Zealand by reason of the signs of an impending mining boom. In this colony the facilities for economical gold mining are exceptionally good, so much so that some of the largest financiers, including Messrs. Rothschild, are now largely interested in New Zealand gold mines. Another 100-per-cent. dividend was declared recently by one of the companies working gold mines in that colony, the products from authentic sources being that the first 720 tons of quartz milled produced 725 ounces of gold, the next 200 tons 214 ounces of gold, and the next 400 tons 463 ounces of gold; and from a cablegram dated March 7 we learn that 'the latest important discovery incontestably proves five feet of gold reef worth 2 ounces per ton.' And a further report adds that the 200-feet level is turning out ore which gives 10 ounces of gold to the ton, and that the 300-feet level is producing ore which gives 20 ounces of gold to the ton."

"Gold was discovered in 1842, but was not worked until 1852, when the mines of Coromandel first attracted attention to the district of Cape Colville peninsula, which still forms the chief center of true lode-mining operations in New Zealand. The yield from these mines was, up to a few years ago, over four and a half million sterling, but this is small when compared with the quantity of alluvial gold obtained in the south island on the western coast."

"However, the principal quartz mines in the north are in the Coromandel and Thames districts, about thirty miles apart. In these localities the reefs have been proved to a depth of over 600 feet below sea-level, but the best mines have as yet been principally confined to the decomposed and comparatively superficial rock. Veins have been discovered and gold obtained at all levels on the ranges from sea-level to an altitude of 2,000 feet. The quantity of gold that has been obtained from some of these reefs is very great, and for a considerable distance the quartz has yielded very uniformly at the amazing rate of 600 ounces to the ton. Such reefs have, however, been exceptional in New Zealand, as elsewhere."

"The present stir in the gold industry is centered on the Tokatea Hill, in the very heart of the Hauraki goldfields, one of the richest gold-bearing districts of New Zealand. This is on the north-eastern side of the north island, and is located on the same line of reefs as the famous Hauraki and Kapanga mines, whilst it is surrounded by other noted producers. According to the government reports for the year 1895, referring to the Coromandel district, 'there is a highly auriferous belt of country from the Tokatea hill to the ocean beach, going through the Kapanga, Blargrove's freehold, and there is no part of the Coromandel district that is more worthy of being prospected than the Tokatea hill. Quartz containing six ounces to the pound has repeatedly been found, and in one claim sheets of solid gold have been obtained' (The Annual Government Report for 1895, by Mr. H. A. Gordon, M. A. I. M. E., F. G. S.) Although the principal quartz mines for gold are in the Thames and Coromandel districts, near Auckland, in the north island, several auriferous reefs are extensively worked in the Otago, Westland, and Nelson goldfields in the south island. There is very good reason to believe that quartz mining in New Zealand is still in its infancy, and that its indefinite extension can be ensured by the judicious application of more capital and the introduction of suitable machinery."

"In the north island alluvial mining is not carried on to any appreciable extent, but in the southern portion of the colony, the alluvial deposits are of enormous extent and value; indeed, with the exception of Canterbury, where gold has not been found in paying quantities, almost the whole area is distinctly auriferous, . . . especially in the districts of Otago, Westland, and Nelson, in which mining operations are carried on over an area of 20,000 square miles. The auriferous sand, or gold drift, as it is called, is of three kinds:

"1. That which is found in the bed of rivers, and which is worked by small parties of miners, as the process requires no large expenditure of capital to effect the separation of the gold.

"2. Thick deposits of gravel of more ancient date, occupying the wider valleys and the flat country, from which the gold can only be obtained by means of considerable expenditure and large engineering work for the purpose of bringing a supply of water. . . .

"The third kind of gold sand or drift is that found along the sea-coast, where the continual wash of the waves produces a shifting action of the sands which are brought down by the river and drifted along the shore, thus producing fine deposits of gold. . . ."

"The alluvial diggings at Collingwood were discovered in the year 1858, those at Otago in 1861, and in 1864 the gold fields of Hokitika proved a great attraction to the mining population of New Zealand generally."

"Alluvial mining has always been the most prolific source of gold in New Zealand, and it continues to yield a supply, as in former years."

The article states furthermore that no accurate returns for any definite period can be obtained, the government report for 1895 of 221,615 ounces being, presumably, approximate only; but that it is admitted that two-thirds of the output is derived from alluvial mining. The chief excitement, however, seems to center about the quartz-vein discoveries, which, as an editorial in the same issue of *Machinery* remarks, "seem almost fabulous, yet they are vouched for by an official inspector." The same editorial further predicts that, "in a country where the distances to be traversed are comparatively so small and the facilities for travelling, either by railway or good roads, are so plentiful; where two-thirds of the land is devoted to agriculture and grazing purposes, water is abundant, and corn and meat are within the reach of the poorest,—it is inevitable that the facts to which we have drawn attention . . . . should largely attract the crowds of adventurous emigrants always on the lookout for a short cut to fortune."

A Wonderful Process for Gold Extraction.

If the claims made for M. de Rigaud's gold-extracting process are even fractionally fulfilled, the cyanid question will lose its importance and interest. Indeed, the representations are so startling that *The Mining Journal, Railway and Commercial Gazette*, in presenting the transcript of the descriptive paper read by M. Camille Grollet before the Société des Ingénieurs Civils de France, feels impelled to remind its readers that it "naturally takes no responsibility for any of the statements therein contained," which are merely reproduced. The brief abstract following is presented in the same spirit.

The process consists of treating auriferous ores with chlorid of sulphur, or, rather, according to the inventor, with tetrachlorid of sulphur,—"an oily liquid of a density of 1.6, brown color, and suffocating odor."

There is, strictly speaking, only one true compound of chlorine and sulphur,—

S_2 Cl_2; this has, however, the property which forms the basis of M. de Rigaud's process,—that of holding an excess of chlorine in solution. This excess is simply held in solution, and under the process is "able to act in the nascent state in the very act of being given off." "It is therefore clear that no more powerful, more energetic, or more perfect solvent for gold exists than this chlorid of sulphur, with which neither chlorine by itself nor cyanid of potassium will bear comparison."

The reagent is prepared by "allowing a stream of washed and dried chlorine gas to act upon sulphur heated to 90° C." under precautions of temperature control; the reddish-brown liquid "tetrachlorid" distils over.

It is important to note the cost: "although the property of M. de Rigaud's process of extracting one hundred per cent. of the gold present is of the highest economic importance, the first cost is also a factor which must not be overlooked." This cost, in Europe, is stated to be a trifle under six cents per ton of ore treated, for the reagent alone. The proportion used is said to be in the ratio of one pound of tetrachlorid to five thousand pounds of ore.

"There are two methods of applying this process,—a rapid and a slow one." The rapid process consists simply in introducing the ore and the chlorid of sulphur together into a lead-lined cast-iron drum provided with an agitator, closing the apparatus and starting up agitation. When the reaction is complete, the drum is tipped up, the chlorid of gold strained off, through a filter of asbestos cloth over lead wires, into "special tanks," and the residual ore washed thoroughly with water to recover the remaining solution. This method, exclusive of the precipitation of the gold, requires four or five hours.

It seems evident from this that the original reagent must be used in solution; otherwise, even supposing the drum to hold a 5,000-pound charge, the proportion of the necessary one pound of chlorid of sulphur which would "escape" afterwards would hardly require any "special tanks" to receive it.

It is not made quite clear why this very simple process is not the one employed commercially; but the paper goes on to describe "the slow process, so-called, which is the true process for treatment on a practical scale," and is "still incomparably more rapid than any other known at present." The plant consists of a series of reaction tanks, a pump, and an exhaustion chamber. The reaction tanks are lead-lined iron cylinders, resting on trunnions, so that they may conveniently be tipped over for emptying, and provided with perforated false bottoms, on which asbestos cloth can be arranged to act as a filter during the process, while afterwards the whole false bottom can be dragged out, thus discharging cleanly and quickly the exhausted ore.

The charge is introduced "in the state of liquid mud" (here probably we get the explanation of the dilution of the reagent), then the chlorid of gold, and then the cover is put on. The chlorid of sulphur begins the work, but the "nascent chlorine," which is to complete it, tends to collect on the top of the tank, and must be drawn down again through the ore. This is the function of the pump provided in the plant. The "exhaustion chamber" is simply a convenient washing-apparatus, by which the gases drawn from the reaction tank are passed through milk of lime, to absorb the chlorine, which otherwise would attack and rapidly destroy the pump parts.

The chlorid-of-gold solution does not go through the pump, but collects in the bottom of the reaction chamber below the pump suction, and is drawn off from time to time, whenever its volume (as indicated by a gage glass) shows the necessity.

When "the greater part of the rich chlorid-of-gold solution is drawn off," wash-water is turned in, and the washings collected in separate tanks, where they concentrate by exposure to the air. The gold in the original concentrated solution is precipitated by an excess of sulphate of iron, and the excess reagent is afterward drawn off and used to precipitate the washings.

"The bulk of the gold is left in the form of a muddy precipitate in the bottom of the tanks. It is chemically pure, and only needs to be dried and melted in the ordinary way." The exhausted tailings "are completely barren, because M. de Rigaud's process extracts the *whole* of the gold contained in them. A works for carrying out the process is being completed at Havre, alongside the Tancarville canal, by the Total Gold Extraction Company, the advantage of the site being the ready discharge of the exhausted tailings into the sea."

Incidental to the process is the partial recovery of both chlorine and sulphur. Interference with the reactions would be caused by the formation of soluble metallic chlorids precipitable by sulphate of iron, and M. de Rigaud does not use his process for ores containing tin, or antimony, or zinc.

A computation is made for a works sufficient to treat one hundred tons of tailings per day. The tailings are assumed to contain ten grams of gold to the ton, and to be purchasable at three francs per ton. Four francs per ton is the calculated cost of all labor, reagents, and expenses, and two francs per ton is set aside for a sinking fund.

This makes a total of nine francs per ton: the returns, "since M. de Rigaud extracts the whole of the gold present," are figured to be (10 grams @ 3 francs per gram) 30 francs per ton,—a profit of 21 on 9, or 233⅓ per cent.

Electric Disturbances in Mine-Surveying.

ELECTRIC lines are extending so rapidly, particularly in districts where a large working population is assembled, that the invasion of the mining regions must be expected as a natural and early development. The installation of electric powers for mine-work also will be accompanied by the creation of magnetic disturbances, which must be guarded against in underground surveying. The experiments of Mr. Lenz in the Westphalian coal-field, noted in *The Engineering and Mining Journal*, have, therefore, a current interest in the United States.

"A point, underground, was selected at a horizontal distance of some 100 yards from the rails of the Bochum-Herne electric railway, and 434 meters (1,420 feet) below it. There, by means of a Fennel's magnetometer with quartz fiber suspension, a series of observations of variation were made, based on a fixed line. The magnetometer was pieviously compared for a long period with the apparatus in the Bochum town park, and the two instruments were found to coincide almost exactly. The first observation, in September, 1895, was made by day, the second by night, when the line was free from current, and the last again by day. While the curve of the day-results exhibited great irregularities, that of the night-results was perfectly regular and in accord with the magnetic records. The irregularities in quite small intervals of time amounted from 2.7 minutes to 5.4 minutes. As at first it was thought that the deviation might be ascribed to the iron-free safety lamps employed, a third observation was made in the morning, the lighting being effected by a stearine candle. The results were exactly the same as on the first day. As the observations were made at a comparatively large distance from other workings, and as the shaft was 200 yards away, it is evident that magnetic observations can, under such conditions, be only satisfactorily conducted during the night, in the absence of the magnetic current."

The connection of the magnetometer deviations with the electric railway current seems to be very strongly evidenced, but a fuller and more detailed investigation would have still more interest. The remainder of the tests indicate a source of disturbance independent of the use of electric power, and are rather curious.

"Another source of error is the safety lamp. Composed of various metals, the lamp in a hot condition sets up thermo-electric currents, which act on the magnetic needle. In order to obtain information on this point, the author placed six mine surveyors' safety lamps free from iron, one at a time, first in a cold condition, then heated, at the pole of a sensitive magnetometer. Of the six lamps examined, two, when cold, had no action on the needle, whilst all acted on it when hot. The deviations observed amounted to from 30 seconds to 160 seconds.

"A new benzine lamp that had not previously been used caused a deviation of as much as five minutes. The deviation increased with the temperature of the lamp. A quite new aluminum safety lamp caused the same deviation when cold as when hot. From these results it follows that the mine surveyor, before making magnetic observations with delicate instruments, should carefully test his lamp.

"The influence of slight magnetic properties may be lessened by holding the light in the prolongation of the magnetic axis. With side lighting great care is necessary."

The Mineral Output of Canada.

Dr. David T. Day's article on the minor minerals of the United States, concluded in this number, will give an interest to a comparison with the figures of Canadian mineral production for 1895. The preliminary statistical table, prepared by the division of mineral statistics and mines of the Canadian geological survey, has just been published, and is thus noted in the *Iron Age:*

"It shows the value of the total production in 1895 of minerals, both metallic and non-metallic, at $22,500,000, of which $6,370,146 was metallic and $15,875,197 was non-metallic, with $254,657 as the estimated value of mineral products not returned. The total production in 1894 was $20,900,000; that in 1893, $19,250,000; that in 1892, $19,500,000; that in 1891, $20,500,000; that in 1890, $18,000,000; that in 1889, $14,500,000; that in 1888, $13,500,000; that in 1887, $12,500,000; and that in 1886, $12,000,000. From this last it will be seen that the production of last year was the largest in any one year during the past decade, and that there was an increase of $10,500,000 from 1886 to 1896. The metallic productions last year consisted of copper of the value of $949,229; gold, $1,910,921; iron ore, $238,070; lead, fine in ore, &c., $749,966; mercury, $2,343; nickel, fine in ore, &c., $1,360,984; and silver, fine in ore, &c., $1,158,633. The non-metallic productions were: asbestos, $368,175; baryta, $168; chromite, $41,301; coal, $7,774,178; coke, $143,047; fire clay, $3,492; graphite, $6,150; grindstones, $31,532; gypsum, $202,608; limestone for flux, $32,916; manganese ore, $8,464; mica, $65,000; ochers, $14,600; mineral water, $111,048; molding sand, $13,530; natural gas, $423,032; petroleum, $1,201,184; phosphate, apatite, $9,565; precious stones, $1,650; pyrites, $102,594; salt, $180,417; soapstone, $2,138. The production of last year exceeded that of the highest amount in any previous year by $2,000,000, the highest amount in any previous year being $20,500,000, which was reached in 1891. It is expected that the returns for the current year will show a still further increase, as the development of the mineral resources of British Columbia is exhibiting great progress."

Cuban Iron Mines.

The Iron and Coal Trades Review (Mar. 27), commenting upon the resources and railways of Cuba, says:

"Cuba is well known to have large resources in the form of iron ore of excellent quality, which have been developed for a considerable time past by American enterprise. The ore ranges from 57 to 62 per cent. of iron, and is remarkably free from phosphorus. From the years 1884 to 1893 the total quantity produced was about 2,093,000 tons, commencing with 21,798 tons in 1884, and ending with 363,000 tons in 1893. The principal ore-exporting concerns are the Juragua and the Ligua Iron Companies. The ore is chiefly mined in open cuts. The Cuban bessemer iron-ore range, as it is described in the United States,—where the ore is wholly consumed,—is east of Santiago de Cuba, and extends in length about 22 miles. The iron outcrops average in width about 300 feet, the surface between them being composed of ore-bearing ground, with dykes of rock varying from 50 to 100 feet in width. Quite recently a new company, styled the Spanish-American Company, has gone into the business, and built docks and railroads. The iron-ore beds are 8 miles from the coast, and at an average elevation of 4,000 feet.

"The Sabinilla and Murato Railroad, which runs north from the port of Santiago de Cuba to Enramadas, has recently been purchased by an American company, who are extending it to some rich deposits of manganese in the interior, which they also own. The road is being thoroughly overhauled, and new iron bridges, track material, rolling stock, and machinery are being introduced.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Mining and Engineering Journals—See Introductory.

Metallurgy.

*5264. The Vast Importance of the Coke Industry. Ill. John Fulton (Showing the value of coke for metallurgical and domestic uses, and describing the various types of coke-ovens with their advantages and disadvantages). Eng Mag-May. 5000 w.

5332. The Canadian Iron Trade (From a commercial standpoint this article is very interesting. It shows that the imports into Canada from the United States are more than double those from England, and that the British trade is rapidly decreasing). Ir Age-April 9. 1600 w.

5389. Blast Furnace Heat Balance Sheet. H. H. Stoek (Translated from the French of M. de Billy's "Farication de la Fonte." Formulæ are derived and all the heat generated in the furnace accounted for). Eng & Min Jour-April 11. 1000 w.

†5395. The Wastage of Gold in the Course of Preparing Jewelry in Bengal. Issan Saran Chakrabarti (The loss in melting is usually a little over one-fourth pie per tola of gold melted. An exposition of Indian goldsmith practice). Ind Engng-March 14. Serial. 1st part. 2000 w.

*5396. The Iron and Steel Industries of South Russia (Illustrated description of the Briansk Company's Alexandroffsky Iron and Steel Works). Ir & St Trs Jour-April 4. 900 w

*5402. Steel Castings and Malleable Iron. C. H. Benjamin (Record of tests made in these materials in tension, compression and shear). Digest of Phys Tests-April. 1200 w.

5407. The Government Iron and Steel Works at Han-yang, China. G. Toppe (Description by the director general, of the Government Iron and Steel Works, consisting of two 60 ft. blast furnaces and mills for turning out merchant iron and steel and rails. There are 34 Europeans employed in the works). Am Mfr & Ir Wld-April 10. 1200 w.

*5410. The Lackawanna Steel Works, United States (Brief description, with cut of the rail conveyer and loader). Ir & Coal Trs Rev-April 3. 1700 w.

*5411. A Blast-furnace Shaft without Brickwork. Franz Büttgenbach (Translated from the *Oesterreichische Zeitschrift für Berg-und-Hüttenwesen*. The author has built furnaces with three rows of bricks and would build one having no bricks, simply an outside sheet-iron casing). Ir & Coal Trs Rev-April 3. 900 w.

*5413. Coal Dust Fuel in the Brown Coal Briquette Industry. Dr. Kosmann (From the *Berg-und Huttenmännische Zeitung* showing the heat efficiency of coal dust compared with coal). Col Guard-April 2. 1000 w.

*5415. Lighting of Blast Furnaces. F. Bicheroux (Prize memoir of the Liège section of the Belgian Association of Mining Engineers. Translated from *La Revue Universelle des Mines et de la Metallurgie, etc.* A description of the system coming into vogue of lighting furnaces by means of grates). Col Guard-April 2. Serial. 1st part. 2600 w.

*5460. Charters Towers Cyanide Works (Brief description of the method used in treating sludges and concentrates). Aust Min Stand-March 5. 700 w.

5465. The Manufacture of Bessemer Steel (Brief description, illustrated by a view in a continental works, from *Black and White*). Sci Am Sup-April 18. 1100 w.

5468. The Production of Open Hearth Steel in the United States (Statistical summary principally from the Bulletin of the American Iron & Steel Asso). Ir Age-April 16. 900 w.

5469. Apparatus for Treating Wire Rods. C. W. Bildt (Translated from *Jernkontorets Annaler*. Scale is removed and oxidation prevented by running the wire or rod through water after coming from the rolls, till it has attained about a low cherry-red heat. The apparatus is illustrated and a diagram shows the resulting properties). Ir Age-April 16. 1100 w.

5471. The Basic Open Hearth Process at Granite City, Ill. (The steel furnaces are illustrated by plans and sections, and are well described. Data and analyses are included). Ir Age-April 16. 900 w.

*5549. The Manufacture and Consumption of Steel Rails (Showing that an enormous quantity of steel is used in the manufacture of rails, more than 47 millions tons of rails having been produced since 1882. The accompanying statistics show the distribution of these rails and the effect of renewals on the market). Ir & Coal Trs Rev-April 10. 1600 w.

5629. Alloys of Iron and Nickel. M. Rudeloff (From the *Verhandiungen des Vereins zur Befrödernug des Gewerbfleisses*. A number of results are given on expansion by heat analyses, tensile, compressive, and drop tests). Ir Age-April 23. 800 w.

*5665. The Manufacture of Iron and Steel in India (Some account of modern work in India in the manufacture of iron and steel. In most establishments iron and steel continue to be made on methods of unknown antiquity. The reasons for non-success of modern attempts are given). Ir & Coal Trs Rev–April 17. 2000 w.

*5666. The Manufacture of Wrought Iron. James Kerr (Describing the conditions of the puddler and the puddling process as they were twenty-five years ago and as they are to-day, dealing with practical work and economy). Ir & Coal Trs Rev–April 17. 1800 w.

*5674. Complete and Cheap Gold Extraction. Camille Grollet (M. de Rigaud's process, which consists of treating the ores with tetra-chloride of sulphur. Abstract of a paper read before the Sociéte des Ingéniéurs Civils de France). Min Jour–April 18. 2500 w.

5677. Commercial Tempering. H. K. Landis (The tempering and annealing of steel in large masses. The operation is briefly described, and a table is given showing the effect). Ir Age–April 30. 1700 w.

†5731. The Volatilization of Silver in Chloridizing-Roasting. L. D. Godshall (A reply to the criticisms of Mr. Stetefeldt upon a former paper). Trans Am Inst of Min Eng–April. 2700 w.

†5732. The Mobility of Molecules of Cast-Iron. A. E. Outerbridge, Jr. (A contribution to the discussion of the Physics of Cast Iron. Tests proving that, within limits, cast iron is materially strengthened by subjection to repeated shocks or blows). Trans Am Inst of Min Eng–April. 3300 w.

†5733. The Embreville Estate, Tennessee. Guy R. Johnson (A brief description of the Embreville property and the iron made there). Trans Am Inst of Min Eng–April. 2000 w.

†5734 The Effects of Additions of Titaniferous to Phosphoric Iron-Ores in the Blast Furnace. Auguste J. Rossi (Some very curious and unexpected results obtained in experimenting in mixing these ores). Trans Am Inst of Min Eng–April. 1500 w.

†5737. The Effect of Expansion on Shrinkage and Contraction in Iron Castings. Thomas D. West (Contribution to the discussion of "Physics of Cast-Iron"). Trans Am Inst of Min Eng–April. 3800 w.

5763. Bessemerizing Nickel Matte. H. W. Edwards (Notes made from the result of work from 1891 to 1894, when the author had charge of a nickel smelting plant in Sudbury district, consisting of two blast furnaces and a set of Bessemer converters (Manhes modification). Eng & Min Jour–May 2. 1500 w.

5765. An Improved Process of Extracting Gold Ores. William M. Grosvenor, Jr. (Description of experimental plant established at Cripple Creek, and that has been in operation about seven months. The process has been patented by J. W. Bailey of Denver. The plant is interesting in its complete automatic and rapid operation). Eng & Min Jour–May 2. 1500 w.

†5783. The Electro-Metallurgy of Aluminum. Joseph W. Richards (Electro-metallurgy is defined, the methods used are classified, the operations for which each is capable of being used are enumerated, as an introduction to the subject. The properties of aluminum are considered and the different kinds of electric processes are taken up in detail, with illustrations). Jour Fr Inst–May. 6200 w.

5789.—75 cts. Treatment of Roasted Gold Ores by Means of Bromine. Richard W. Lodge (Reprinted from Trans. of Am. Inst. of Min. Engs., Florida meeting, March, 1895. Experiments where bromine seemed to have many advantages over chlorine). Tech Quar–Dec. 800 w.

5790.—75 cts. The Cyanide Process as applied to the Concentrates from a Nova Scotia Gold Ore. Richard W. Lodge (Reprinted from Trans. of Am. Inst. of Min. Engs., Florida meeting, March, 1895. Work of W. A. Tucker which seems to disprove the view that the presence of arsenic interferes with the extraction of gold by the cyanide method). Tech Quar–Dec. 800 w.

†5820. The Cassell-Hinman Gold and Bromine Process. Parker C. McIlhiney (This process is for the extraction of gold from low grade ores, and those which will not give up their gold to amalgamation). Jour Am Chem Soc–May. 2200 w.

†5822. The Copper Assay by the Iodide Method. Albert H. Low (The method is described and the writer states that for most accurate technical work he prefers it to all other methods). Jour Am Chem Soc–May. 1600 w.

5848. Notes on Gold Milling. E. B. Preston (Considers the importance of the site, the construction, mill details, and practices in the first part). Can Min Rev–April. Serial. 1st part. 12000 w.

*5855. The British Aluminum Works at Fayers (Illustrated description). Elec Eng, Lond–April 24. Serial. 1st part. 1600 w.

†5928. The Manufacture of Iron and Steel in Southern India. W. Naylor, in the *Madras Mail* (An account of the successful introduction of European methods, and the excellent quality of the steel). Ind & East Eng–April 11. 1700 w.

5934. Notes on the Hydrometallurgy of Gold and Silver. W. Geo. Waring (Calling attention to facts in hydrometallurgy that are not well understood, and stating that the advances of the present day do not consist in the discovery of new processes, but in improvements in manipulation of the old and well-founded methods). Eng & Min Jour–May 9. 2700 w.

Mining.

5321. The Hydraulic Gravel Elevator (Description of the operation of a hydraulic giant and elevator, with illustrations of each in operation. Instances are given where the gravel is elevated from 40 to 96 feet). Min & Sci Pr–April 4. 1600 w.

*5390. Golden New Zealand (Introduction to the detailed report of the Minister of Mines, giving the history of the past year in a summarized form). Min Jour–April 4. Serial. 1st part. 4300 w.

*5391. Mining in the State of Chiapas, Mexico (Read before the Inst. of Mining and Metallurgy. Transportation, climate, labor, geology, etc., are intelligently described). Min Jour-April 4. 3800 w.

*5412. Underground Haulage by Electric Locomotives. Léon Sindic (Communication to the Charleroi section of the Union des Ingénieurs de Louvain. Showing how the system is applied both with accumulators and by the use of a cable, with estimates for each case). Col Guard-April 2. 2700 w.

*5457. Flux for the Smelters (Description of a limestone quarry and plant extracting stone for the smelters. Illustrated by two views). Aust Min Stand-March 5. 800 w.

*5462. Lansell's Pneumatic Water-Raiser and Ventilator (Description of the pneumatic method of draining mines by means of successive lifts, to a depth of 1560 ft. A section illustrates the arrangement as used at a Bendigo, Victoria, Mine). Aust Min Stand-March 12. 1200 w.

*5463. The Auriferous Beach Sands on the North Coast (N. S. W.) J. E. Carne (A full description from the annual report of the New South Wales Department of Mines) Aust Min Stand-March 12. Serial. 1st part. 5200 w.

5529. Wire Rope Tramway at the Bunker Hill and Sullivan Mines, Idaho (General description illustrated by profiles and two excellent views. It has been operated since 1890, with a great saving in transportation expenses. There is one span of 1100 ft. over a town, at a height of 125 ft. above the houses). Eng & Min Jour-April 18. 600 w.

*5531. Experimental Trials with an Electrically-Driven Winding Engine. Ingenieur C. Köttgen (A technical paper, from *Glückhauf*, giving the results of experiments made by Siemens and Halske, showing that equal ease in handling and safety can be obtained, as with steam or compressed air. The motors were direct gear connected). Col Guard-April 10. 2500 w.

*5532. Periodicity of Fire-damp. A. Doneux (From *Cosmos*. Supplementary to a previous article on the same subject). Col Guard-April 10. 550 w.

*5533. How a Mine May Be Dry but not Dusty. George Fowler (Paper read before the Chesterfield and Midland Counties Institution of Engineers. The author says that watering a mine to prevent dust may not be necessary; that dust is produced principally in transporting the coal through the mine, and recommends closed cars). Col Guard-April 10. 2400 w.

*5574. The Mineral Wealth of New Zealand (An article setting forth the varied resources and the exceptional facilities for economical gold mining, with a map giving the chief localities of the different ores). Mach, Lond-April 15. 5000 w.

5630. A California Electric Mining Plant (A 300-h. p., 30-inch Girard water wheel is coupled direct to a 150-h. p., 1000-volt direct current electric generator driving a pump which supplies water to the gold sluices). Min & Sci Pr-April 18. 800 w.

5631. California Will Be the Leader (A general article descriptive of the gold resources of California). Min & Sci Pr-April 18. 3000 w.

†5633. The Coal Supply of India (A brief résumé of the coal mining industry in India. From the *Pioneer*). Ind & East Eng-March 28. 1800 w.

5662. Electricity for Mine Pumping. William Baxter, Jr. (Considering the advantages of electricity as compared with compressed air and steam, both from the mechanical standpoint and efficiency). Eng & Min Jour-April 25. 1700 w.

*5670. Firedamp, the Formenophone and the Indicating Safety Lamp. Ernest Hardy (A communication from the inventor of the formenophone as to the application of sonorous vibrations for analyzing gases of different density, with brief discussion of other methods for indicating the percentage of firedamp). Col Guard-April 17. 2000 w.

†5735. The Hydraulic Elevator at the Chestatee Mine, Georgia. W. R. Crandall (The construction and operation of a type of portable hydraulic lift or gravel-elevator, with a description of the practice at the Chestatee mine). Trans Am Inst of Min Eng-April. 1300 w.

5764. Ore Deposits of the Little Rocky Mountains, Montana. Walter Harvey Reed (Notes upon the geology and ore deposits of this region made by the writer during a visit to the region as geologist for the government). Eng & Min Jour-May 2. 1900 w.

5766. The Microscope as Used in Mining. J A. Edman (Address delivered before the Microscopical Society in San Francisco. Showing that the microscopical study of ore deposits to be not only very interesting, but helpful if not absolutely necessary in determining the physical conditions of the ore before deciding on a plant and milling process). Min & Sci Pr-April 25. 2500 w.

5817. Historical Notes on Early Plans for Coal Washing. F. J. Rowan (From the *Transactions* of the Mining Institute of Scotland. Description of some systems the completeness of which are surprising because of their early date). Am Mfr & Ir Wld-May 1. 1100 w.

*5861. The Law Relating to Truck and Checkweighing (An official memorandum drawn up by the direction of the Secretary of State for the Home Department. The checkweighing clauses in the Coal Mines Acts are considered at length). Col Guard-April 24. 10000 w.

*5862. Gob Lowering Balance with Water-Brake (From a communication by the Management of the Saint-Eloy Collieries, Puy de, Dôme, France, to the Société de l'Industrie Minérale, Saint-Etienne. Illustrated description). Col Guard-April 24. 1200 w.

5864. Notes on the Grand Lake Coal Field of New Brunswick. R. G. E. Leckie (Map with sections of surface seam, and description of location, area, analysis, cost of mining, etc). Can Min Rev-April. 1800 w.

*5904. Placer Mining. III. Arthur Lakes (A general and specific account of placers, their formation, distribution and the construction and development of the different machinery and devices used in working them). Col Eng–May. 5800 w.

*5906. Compressed Air Haulage (Description of the plant at the Susquehanna Coal Co.'s No. 6 Colliery. Some novel features peculiar to this plant which successfully meet conditions existing in many coal mines are illustrated and described. Editorial also reviews compressed air as a motive power). Col Eng–May. 5000 w.

*5926. Coramba Creek Goldfields (N. S. W.) (Describes the general geological features, and the mines). Aust Min Stand–March 26. Serial. 1st part. 3000 w.

Miscellany.

*5269. Minor Minerals of the United States. David T. Day (Classifying minor minerals according to conditions of supply and demand, and stating the sources and uses of each). Eng Mag–May. 3900 w.

5308. The Inventor of the Bessemer Process (Editorial review and criticism of the claims made for William Kelly as the original inventor of the Bessemer Process, by J. D. Weeks in the annual address of the American Institute of Mining Engineers, and also a review and approval of Sir Henry Bessemer's answer to Mr. Weeks). Ry Age–April 11. 1400 w.

5388. The Mineral and Metal Production of the United States in 1895 (The annual statistical report giving the production in quantity and value, of 69 mineral and metallic substances produced in the United States, showing an increased production in 1895 over 1894 of 15.5% in value). Eng & Min Jour–April 11. 5400 w.

*5449. Missouri Building and Ornamental Stones. Charles R. Keyes (This proposes to be a well illustrated and interesting series of articles. Special attention is given to geological characteristics, and this will have weight being written by the state geologist). Stone–April. Serial. 1st part. 1200 w.

*5450. American Slate in Great Britain (Comments upon the probable large future trade for American slate in Great Britain, by *The Quarry* of London ; with the editor's opinion upon the subject). Stone–April. 1300 w.

*5451. Stones from Norway and Sweden. Hern Lund (Description of the soap stone and slate industries, showing their properties and how they are applied). Stone–April. 800 w.

*5452. Building a Business. Fred P. Ronnan, in *Fame* (How a quarry was boomed into a thriving business. An entertaining article). Stone–April. 2200 w.

*5458. The Charters Towers Pyrites Works (Brief description). Aust Min Stand–March 5. 500 w.

*5459. The Yalgoo (Murchison) Gold Field (W. A.) H. P. Woodward (Brief description from the government geologist's report). Aust Min Stand–March 5. 1100 w.

*5461. Kerosene Shale in New South Wales —The Genowlan Mine (General description with production and analysis). Aust Min Stand–March 12. 1700 w.

*5530. The Lancashire Coal-field. M. E. (A short geological description showing arrangement of strata). Col Guard–April 10. 1200 w.

5658. Some Considerations as to Coke (Editorial review of the present situation of the coke supply). Ir Tr Rev–April 23. 1200 w.

5659. Mesabi Ores and Top Explosions. F. E. Bachman (A letter giving an account of experiments made which seem to support the writer's theory that the prevention of explosions is reduced to the selection of an ore mixture not depositing an excessive amount of carbon). Ir Tr Rev–April 23. 600 w.

5661. Cost of Gold Production (Editorial review of the present cost of milling gold ores, with reference to the report of the Robinson Gold Mining Co., which is regarded as a model of clearness and information of technical value). Eng and Min Jour–April 25. 1800 w.

*5669. State of Mining and Metallurgy in France (From a report founded upon data collected by the Ingenieurs des Mines during 1895, to the French Minister of Pubiic Works). Col Guard–April 17. 2200 w.

†5736. The Assay by Prospectors of Auriferous Ores and Gravels by Means of Amalgamation and the Blowpipe. William Hamilton Merritt (The method of field testing of gold ores, as practiced in the Kingston School of Mining, is described, pointing out some points in which it differs from that presented in a recent paper by R. W. Leonard). Trans Am Inst of Min Eng–April. 1500 w.

†5739 Standard Physical Tests for the Product of the Blast Furnace, and their Value. Ill. Thomas D. West (Discussion of this work. The writer claims that progress in the science of either making or mixing iron requires the study of the physical as well as the chemical properties). Trans Am Inst of Min Eng–April. 5000 w.

†5823. The Deposition of Gold in South Africa. S. Czyszkowski. Translated by H. V. Winchell (The subject deals with the theories of the origin of the gold deposits in the unique auriferous region of the Transvaal. Origin of mineral waters. Circulation of waters, both surface and deep seated. Thalwegs and metalliferous strata (niveaux). General geological sketch of South Africa. Age of the gold deposition. Deposits of Witwatersrand. The terrane enclosing the reefs and origin of the latter. Deposits of the "de Kaap" district. Structure of the terrane enclosing these deposits. District of Lydenburg.—Mashonaland.—Matabeleland Origin and mode of formation of the reefs. Orogenic and metalliferous phenomena of South Africa. Analogy with the South of Spain, and ten conclusions). Am Geol–May. 7000 w.

*5905. The Dayton, Tenn., Disaster. W. M. Gibson (Full particulars and descriptions of the mine previous and subsequent to the explosion of the 20th of Dec. last whereby 28 men and boys lost their lives). Col Eng–May. 3000 w.

*5925. The Scientific Exploration of Central Australia. W. A. Horn (The origin of the expedition, the natural features of the country, Chambers' pillar, Ayers' Rock, and the climate are described). Aust Min Stand–March 26. 3600 w.

Increasing Profits in Gas Manufacture.

Dr. F. Auerbach, in the *Progressive Age* (April 15), thinks "too little attention has been paid to a detail which would not only serve to reduce the expenses of gas manufacture, but would sensibly augment the receipts. This is the purification of the gas. While the other by-products—coke, tar, ammonia water—have become a source of revenue, and their fluctuations in price closely watched, spent purifying materials are regarded as valueless, giving a profit only in extraordinary circumstances.

"This indifference is especially unjustifiable, as the results in other countries—Germany, for example — have demonstrated the possibility of rendering the spent materials salable at a good price. It must not be thought that the large works only are in position to attain this result. When it is a question of refinements that render necessary great constructions or costly additions, the large works undoubtedly have the advantage. This is not the case, however, with purification, where all that is necessary is to take some precautionary measures, when the profit will follow of itself, and, moreover, a profit that is very great in proportion to the expense incurred, and due to the great value of cyanids. Since enormous quantities of cyanids have been consumed in the extraction of gold in the mines of Africa and other countries, the demand has largely increased, and the saturated purifying materials of gas-works have become far more valuable, as it is from them principally that the cyanids were obtained. This explains why manufacturers of prussiate of potash pay to-day over eight cents a pound for the Prussian blue contained in their goods." The gains possible to be made under these conditions are indicated as follows: "Under these conditions, it is evident that gas-works have every interest in increasing to the utmost the proportion of Prussian blue contained in their materials. Assume, for example, the fundamental price of 8 1-6 cents per pound; a material containing 12 per cent. of the blue will have a value of $21 a ton, less the cost of transportation from the gas-works to the prussiate factory, which we will assume to average $3; there remains $18 per ton. By the same calculation, a material containing 6 per cent. will be worth but $8, and one containing 4 per cent. will be worth only $4 a ton. These last figures would be still further diminished by the fact that the prussiate manufacturers have not only the same cost of transportation, but also the same cost of working up the rich materials as the poor, thus compelling them to offer a price that lessens as the amount of blue contained becomes smaller. Many gas companies have already turned their attention to the enrichment of their purifying materials, and are obtaining 10 per cent. and 12 per cent., and we can even mention one case in which 15.2 per cent. is reached.

"Let us now see what increase of profit will result from perfecting this method. A works of moderate size, consuming 200 tons of new purifying material annually, at an expense of $6 a ton, will pay $1,200 a year for its material. These two hundred tons, when increased by the absorption of sulphur and cyanid, will produce 350 tons by the end of the year, if saturated to 12 per cent. At $18.60 per ton, this will be worth $6,510, and the result will be a profit of $5,000, in round figures. If a material containing but 10 per cent. of the blue is obtained, the profit will be $4,000. It is evident that this profit is almost in proportion to the size of the works, but even in the smallest it should exceed $200, and in the largest should reach enormous sums. In fact, Dr. Knublauch, one of the most competent chemists in gas matters, in treating this question in a lecture before the 'Deutsche Verein von Gas und Wasserfachmannern' last year, expressed himself in these terms:

'While materials are often obtained which yield little or no cyanid, a good material yields 800 to 900 francs and more per 10,000 kg. ($16 to $18 per gross ton), and dry purification should to-day be an important source of revenue.'"

Dr. Auerbach agrees with Dr. Knublauch that insufficient condensation before purification exerts a detrimental influence upon purification, and thinks that the quality of oil gasified is of less importance than is usually assigned to it. He states also that analyses of saturated materials taken in a great number of European works has shown that complete success is attainable by employing only a material which, while possessing the property of removing from the gas the sulphur-hydrogen compounds and cyanids, is susceptible at the same time of giving a valuable final product. In France the Laming material is most used. This is composed of sawdust mixed with lime, soaked with a solution of sulphate of iron, and oxidized in the air; but this material does not now conform to the more advanced scientific practice. In England and Belgium materials richer in iron oxid are used. France has begun to use such materials, but this change in practice has not been satisfactory, "the reason being that these materials are not adapted to purification, as other qualities are also necessary. From a chemical point of view, the materials should not contain an appreciable quantity of deleterious substances, such as lime, alkaline or acid salts, and the iron oxid should be in a state susceptible to ready absorption,—that is to say, completely hydrated. From a mechanical point of view, it is, above all, necessary that the material should of itself be so light and porous that it does not become necessary to mix it with light foreign substances, for such mixtures entail extra expense, reduce the strength of the oxid, and lessen the value of the exhausted material.

"Many of the materials sold in commerce do not fulfil these requirements. The artificial products often contain iron oxid in an inactive state; and the natural minerals are too heavy and require a mixture, or too hard and require costly preparation, or contain too much earth and soon become inactive. Few materials unite in themselves all the qualifications necessary to effective purification and good production of Prussian blue, and it is certainly to the qualities of the material that we must attribute the excellent results mentioned above."

Steam Disinfecting Apparatus.

A SANITARY inspector gives in *The Sanitary Record* for March a description of cheap and easily-constructed steam disinfecting apparatus, which he claims to have used with very satisfactory results. The apparatus is designed to take full advantage of the latent heat of steam. An abstract of his description is here made.

The boiler is of the self-contained vertical type, two feet in diameter by four feet high, tested to one hundred pounds per square inch, and of mild steel throughout. It is fitted with usual gages, etc., and is fed with water direct from the town mains.

The disinfecting chamber is cylindrical, of steel, four feet in diameter and six feet long. The door opens full width, and, when closed, is held in place by nineteen 1⅛-inch bolts. The shell is of ⅜-inch plate, the closed end being of 7-16-inch plate, and the door is ⅝ inch thick. To fasten or unfasten the door requires about two minutes.

A combined steam and vacuum gage is fixed on the top, the whole forming a large machine. The cylinder is covered with asbestos one inch thick, in order to conserve the heat. Steam is turned in preferably at the top, and there is a drain pipe attached at the bottom. When the steam is turned in, it remains at the top and gradually displaces the air, which passes out through the drain pipe, and may be heard spluttering out together with the water. Not a particle of steam, however, will escape, until all the air is expelled. The non-conducting qualities of air render this expulsion of all air absolutely necessary, and a pressure of ten, fifteen, or twenty pounds can be obtained in a few minutes.

The last time the apparatus in question was used, a feather-bed, weighing eighty pounds, was rolled in tightly, bound with cord, and placed in the receptacle. As near the center of the bed as possible a registering thermometer was inserted. When taken out, after being exposed for twenty-five minutes to a pressure of fifteen pounds above that of the atmosphere, the thermometer registered 246 deg. F. The full amount of sensible heat due to that pressure is 250 deg. F. The bed then weighed only a quarter of a pound more than when put in the machine, although condensation had been going on freely all the time. Afterwards, the following test was made to see how great a vacuum could be obtained. The chamber was heated with ten pounds per square inch of steam, which was then blown off to atmospheric pressure and all taps closed. After waiting two hours for it to cool down, the combined pressure and vacuum gage showed the vacuum to be equal to twenty-eight inches of mercury. The test with the feather-bed goes to prove that the thickness of material makes but little difference, so long as the air is expelled; and the expulsion of the air is proved by the good vacuum produced.

To assist in drying the disinfected articles, a coil was made of about forty-two feet of ¾-inch galvanized pipes; but I do not now think this absolutely necessary, as the heat stored in the walls of the cylinder, which weighs over a ton, is sufficient to do all the drying, if the door be opened about one inch to allow the moisture to escape. A sliding basket made of ½-inch tubes, galvanized and lined with wire netting, is provided to receive the clothing, etc.

It has been urged that textile articles may get scorched in such an apparatus. This, however, cannot occur with the use of moist steam. Colors in the cheapest class of materials do not run in the least, while velvet is distinctly improved, as also is crape. It is, however, unnecessary to have the chamber under any pressure, save that of the atmosphere, when using moist steam, for the reason that, as the sensible heat increases with the pressure, so also in almost the same proportion does the latent heat decrease. It will thus be seen that little advantage is to be gained by using steam under pressure, while the risks are greater, and more difficulty is experienced in feeding the boiler.

When a dry chamber is used, the steam may be either superheated by means of a steam jacket containing a higher pressure, or simply by the same heat and pressure in a jacket. In either case the result is the same. No latent heat is used, and air or dry gas would do equally as well.

Tyndall and others have shown that the rapid destruction of some germs requires the application of moist heat, and that dry heat fails to sterilize articles which would be perfectly sterilized in a much shorter time by moist heat, even at lower temperature. The specific heat of most solids is small as compared with that of water; yet, when heated in an atmosphere of steam, they often contain sufficient heat to evaporate all the water condensed upon their surfaces. This, however, would not be the case with porous materials, like clothing. Hence the drying coils in the chamber are a useful adjunct for delivering the articles dry and in good condition, whenever the heat contained in the walls of the disinfecting chamber is not sufficient.

Steam Road-Rollers and Gas Pipes.

THE gas companies in England have found that the use of steam road-rollers has had a bad effect upon gas pipes under streets. We have not heard this complaint from gas companies in the United States; but it is the practice here, at least in the colder parts of the country, to place both water and gas mains deeper in the earth than in England. The trouble has become sufficiently pronounced in England to be made the subject of a paper by Mr. Norton H. Humphrys, Assoc. M. Inst. C. E., printed in *Journal of Gas Lighting*, who asseverates that, while the results of steam road-rolling may be entirely satisfactory to civil engineers, the gas companies do not regard them with complaisance. An abstract of this article follows:

On good roads accustomed to carrying

a large and heavy ordinary traffic, including four-horse vans and traction-engines, and which have been well maintained and kept in good order, the steam roller does not put itself much in evidence. But, when one of these implements is for the first time put upon a by-street or a country road accustomed to small and light traffic, and which has received but little attention in the way of maintenance, beyond an occasional scrape in unusually wet weather and a sprinkling of stones from a cart at rare intervals, the gas engineer becomes more intimately acquainted with "The Luck of Eden Hall" properties possessed by the steam roller than is good for his own comfort or the prosperity of his undertaking. Difficulties from drawn services and fractured mains—ranging from the slight crack of a few inches long up to complete severance of the pipe—become common occurrences.

A comparison of gas pipes with water pipes with reference to their respective requirements shows that this is not because water engineers are more thorough in their work. Following on the lines of the usual rule that, if the gas gives a bad light, the company is at fault, it is agreed that, if the gas pipes break, they must be bad pipes; and many members of corporations, etc., arrive at the conclusion that there must be special negligence in putting down, or selecting, the sections or quality of the pipes to be used for the conveyance of gas. So far from getting any sympathy in their misfortune, which has arisen from causes that could not possibly have been foreseen, the unfortunate gas company is blamed for not laying down pipes at a reasonably sufficient depth, or for purchasing cheap stuff of a rotten or ginger-bread character. A common argument in support of this view is the fact that gas pipes are injured more frequently than water pipes.

The relations between the shape of the roller, its weight, and the mode of using it to the damage done upon the pipes is discussed at length, and the tendency toward using greater weight is depreciated. Water engineers have not been more prudent, nor have they exercised more care or foresight as to possible contingencies. Neither do they generally do their work in a stronger or more substantial manner than do gas engineers. The trouble is simply a natural consequence, due to the different natures of the services performed. The internal pressures to which the gas service is exposed is a mere trifle,—a matter of a few ounces per square inch. But water pipes are subjected to heavy pressure in low levels, representing a large number of pounds per square inch. Gas pipes in themselves are not interfered with by frost, except as regards its effect on the soil surrounding them; but the formation of ice in water-pipes must be prevented, as it not only stops the supply, but also fractures the pipe. It would be as reasonable to adduce the fact that the main sewers are never injured by the roller, as to compare water pipes with gas pipes.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Municipal Engineering in the American, English, and British Colonial Engineering and Municipal Journals—See Introductory.

Gas Supply.

*5338. Water Gas in Birmingham (Notes on water gas, with a brief account of plant named). Arch, Lond–April 3. 2200 w.

5366. Carbide of Calcium—Acetylene Gas (The present status of the manufacture, patents and literature on the subject. This is a most thorough and valuable report of a commission of able experts sent by *Progressive Age* to Spray, N. C., for the purpose of making full, accurate, and impartial tests of the cost of carbide of calcium, in the interest solely of scientific truth. The report covers the following topics, viz.: past history; mode of production; synthetical possibilities; the flame temperature controversy; acetylene for power; acetylene as an illuminant; and liquified acetylene. It is accompanied by personal sketches of the *Progressive Age* commissioners (with portraits) substantiating their fitness for conducting such an investigation; a list of American and foreign patents for production of calcium-carbide and production and distribution of acetylene gas, and an exhaustive bibliography of the subject. The descriptive part is illustrated with engravings. Never before has so complete an exposition of the whole subject been made). Pro Age–April 15 12500 w.

5368. Enrichment of Purifying Materials and the Value of Spent Material. F. Auerbach (The aim of this article is to call the attention of gas-works to the considerable value their spent material may attain, by the exercise of greater care in selection of fresh material in condensation and in washing). Pro Age–April 15. 1500 w.

5464. Cheap Gas and Coke for Boston and Suburbs (Digest of the testimony of H. M. Whitney before the Legislative Committee on Manufactures, giving description of the process of coking, utilization of residues, and gas statistics of Massachusetts and Great Britain). Sci Am Sup–April 18. 2200 w.

*5497. The Carbide-Acetylene Patents (Interview with Prof. Lewes. Notwithstanding the action of the British House of Lords in rejecting the Willson bill, Prof. Lewes thinks the electrical furnace patents, and not the Bullier or Willson patents, will be the governing factor in the production of calcium carbide, and that this manufacture will not be open to the public till the electrical furnace patents lapse. He also has much to say with reference to practical points regarding the safe and efficient use of acetylene in illumination, and this is the most valuable feature of the reported interview). Gas Wld–April 11. 2500 w.

*5501. The Recovery of Tar and Ammonia from Blast-Furnace Gases. A. Gillespie (Read at meeting of the Inst. of Engineers and Shipbuilders in Scotland. Subject treated in the main as a practical question of economy in the manufacture, with a review of processes available for the purpose). Jour Gas Lgt–April 7. 3000 w.

5571. The Fire Hazard of Acetylene (Present attitude of fire underwriters toward the employment of acetylene. The liability to explosions is considered as a special fire hazard, etc. Abstract of an article in *Am. Exch. and Review*). Am Gas Lgt Jour–April 27. 600 w.

5759. On the Nitrogen and Nitrogenous Products of Coal. Dr. Knublauch (Paper read before the German Gas Assn. A record of several years experiments at the Cologne gas-works, and in the author's own laboratory). Pro Age–May 1. 1000 w.

Sewerage.

5328. Sewer Intersections at Baltimore, Md. Charles P. Kahler (Description with explanatory diagrams of the chamber or conical section as employed in Baltimore. Also accompanied photographs reproduced in half-tone). Eng News–April 9. 350 w.

5534. The Natick, Mass., Sewage Reservoirs (Very complete illustrated detailed description). Eng Rec–April 25. 1800 w.

5536. Winchester, Mass., Sewer Details (Illustrated detailed description, also comprising the methods employed by the sewer committee in using help resident in the town, and the method of proceeding whereby applicants obtain house connections). Eng Rec–April 25. 1100 w.

5626. Maintenance of a Separate System of Sewers. T. Harry Jones (Paper relates to sewers in Brantford, Ont. These sewers were built and are now maintained by the city with day labor. Full account of the system is given, and, also details of practice in flushing). Eng News–April 23. 900 w.

*5637. The Sewerage System of Indianapolis. Charles Carroll Brown (An excellent, comprehensive detailed illustrated description of an interesting example of sewer work). Jour Assn of Eng Soc–March. 7000 w.

5920. A Small Sewage Disposal Plant (General description of plant, with plans at the Rockingham County farm, New Hampshire). Eng Rec–May 9. 450 w.

Streets and Pavements.

5331. Tests of Paving Brick at Williamsport (Results of abrasion and absorption tests on fifteen kinds of paving brick submitted with bids at Williamsport, Pa). Eng News–April 9. Table.

*5400. Paving Bricks. F. Paul Anderson (The results of a large number of tests made on fire clay brick and paving brick, giving deductions, precautions, method of testing and numerous half tone illustrations of crushed specimens). Digest of Phys Tests–April. 3000 w.

5746. Brick Street Paving in Jackson, Mich. (Illustrated description of methods employed in repaving a street 68-ft wide between curbs, and 99-ft. wide between property lines, in Jackson, Mich., and which had been previously paved with McAdam thoroughly compacted by long use). Eng News–April 30. 1300 w.

*5784. The Pavements of an Australian City. F. A. Campbell (Illustrated general description). Pav & Mun Engng–May. 1000 w.

Water Supply.

5291. Toledo, O., Water Works (Illustrated detailed description. The department is said not only to pay its own way, but also to make large profits). Fire & Water–April 11. 1700 w.

5385. The Providence Filtration Experiments (Reprinted from Appendix to the Annual Report of the Rhode Island State Board of Health. The experiments were under the direction of the city engineer, J. Herbert Shedd, and occupied a period of nearly one year. Results and data are given). Eng Rec–April 11. 2800 w.

†5408. Delhi Water Works Scheme. B. Parkes (Review of a report submitted to the Delhi (India) Municipal committee, in which it is proposed, under peculiar and interesting conditions to obtain a supply for the city from a group of 211 connecting wells. A map of the district and of the city accompanies the report). Ind Engng–March 7. Serial. 1st part. 1700 w.

*5477. The Water Supply of the Paris Suburbs (Illustrated general description). Eng, Lond–April 3. 700 w.

5484. The Lowell, Mass., Water Works (Describes and illustrates a notable increase in the driven well system of this city already noted for its driven-well system and its filtration methods). Fire & Water–April 18. 700 w.

5526. Salem, Mass., Water Works (Illustrated description. The first part deals principally with installations, costs, and capacities. It is illustrated with portraits of the Salem water board, the building at the pumping station, the Worthington engine—in use since 1868—and a view of Lake Wenham, whence supply is derived). Fire & Water-April 25. Serial. 1st part. 700 w.

5527. Mechanical Filtration (Results of experiments performed by Mr. Edmund B. Weston, assistant city engineer in charge of Providence (R. I.) water department. The results of comparison between natural and mechanical filtration are decidedly favorable to the latter. A variety of filtration appliances were tested). Fire & Water-April 25. 2000 w.

5535. The Friction in Several Pumping Mains. Freeman C. Coffin (Paper read before the New England Water-Works Assn. Results of experiments made upon pumping mains in different cities, with tabulated data). Eng Rec-April 25. 2200 w.

5634.—$1.50. The Astoria City Water-Works. Arthur L. Adams (An instructive and interesting detailed, illustrated description, accompanied by cost tables). Trans Am Soc of Civ Eng-April. 17000 w.

*5668. The Water Supply of Small Towns and Rural Districts. Ill. Percy Griffith (Paper read before the Society of Engineers. The writer has for eight or ten years been associated with the design and construction of such works and is convinced that a study may be made of them with advantage. The paper deals with works supplying a maximum population of 10,000, and shows points in which both theory and practice as applied to large undertakings are quite distinct from those applicable to small ones). Ind & Ir-April 17. Serial. 1st part. 3000 w.

5748. Bacteriological and Chemical Studies of Public Water Supplies (An argument supporting the proposition that while both the chemist and bacteriologist are necessary to determine the character of potable water, too much reliance upon reports of bacteriologists alone may mislead the public, and stating conditions under which the services of both are required). Eng News-April 30. 1500 w.

†5782. The Filtration of City Water Supplies, with Special Reference to the Needs of the City of Philadelphia (An argument for the filtration of water drawn from the Schuylkill River fo, domestic supplv, by Edwin F. Smith; with disr cussion by A. K. Leeds, L. Y. Schermerhorn- J. C. Trautwine, and others). Jour Fr Inst-May. 6000 w.

5835. Comparison of the Original Computations and the Actual Gaugings of the New Steel Conduit of the Rochester, N. Y., Water-Works (The data for comparison were found by very careful gaugings at different points, and a curious set of conclusions for the case of a riveted steel pipe, made of alternate inside and outside courses, is illustrated diagrammatically. From these data formulæ for the constriction, for the enlargement, and for the total loss of head in such pipes are deduced). Eng Rec-May 2. 3500 w.

†5891. The Queen Lane Division of the Water Works of Philadelphia (Part I. The Boilers, by John E. Codman, gives an illustrated description of the boiler installment. Part II. The Pumping Engines, by Thomas H. Mirkil, Jr., and Part III. The Engine and Boiler Houses, by F. L. Hand are illustrated, described and discussed). Pro Eng's Club of Phila-April. 2800 w.

5914. The Specifications for a New Water Supply for Jersey City. C. C. Vermeule (Reply to an editorial criticism in issue of Eng. News (April 30) on report of Engineer C. C. Vermeule, relating to the proposed Jersey City water supply, and an answer to the communication, by the editor of the named journal). Eng News-May 7. 2800 w.

5919. The Ottumwa, Iowa, Filters (General description of plant). Eng Rec-May 9. 600 w.

Miscellany.

*5286. Some Practical Ideas on Steam Disinfecting Apparatus (The subject is discussed both theoretically and practically. A description is also given of an apparatus, cheaply constructed and considered adapted to the service of health boards in municipalities). San Rec-April 3. 1700 w.

5367. Candle Power and Luminosity. W. H. Birchmore (The prevalent confusion of mind upon these subjects is attributed first to the neglect of proper consideration of the objects for which artificial light is used, and second, to the use, or rather the abuse, of the Bunsen photometer, an apparatus now used for a purpose of which its inventor never dreamed, and against which use, were he now alive, he would probably protest most loudly. From these standpoints the article proceeds to discuss the Bunsen photometer, and to show that it measures emissive power only, and that it is not at all adapted to the comparison of high temperature lights such as have latterly come into use). Pro Age-April 15. 4000 w.

*5785. The Chemical Relations of Asphaltum. S. F. Peckham (A résumé of work done in this field up to date, and an indication of the lines upon which future chemical investigation should be directed). Pav & Mun Engng-May. 1500 w.

*5786. A Rapid Method of Apportioning Cost of Private Street Works. Thomas Caink (A simple method with the use of an instrument devised by the writer, whereby the computation of cost of street improvements to be charged abutting owners, can be made with practically no calculation and in a fraction of the time needed in the ordinary methods). Pav & Mun Engng-May. 600 w.

*5810. The Judgments in the Incandescent Gas Light Trials (The full text of the judgments is given with editorial comment. These judgments are a complete compendium of the facts as presented in the evidence in this famous litigation). Gas Wld-April 25. 16000 w.

5918. The Value of Water Power (Editorial, dealing with the general and special conditions and circumstances that should be considered in the condemnation of water supplies for municipal purposes). Eng Rec-May 9. 1200 w.

RAILROADING

Articles of interest to railroad men will also be found in the departments of Civil Engineering, Electricity, and Mechanical Engineering.

The Future for American Railroaders.

PRESIDENT HAINES's address before the American Railway Association at the Cincinnati meeting is notable for the excellent and timely review which he makes of the possibilities open to American enterprise, or, to put it more strongly and accurately, the necessities which will soon be incumbent upon it.

After summing up the valuable results already secured through the association in standardizing time, train-rules, car-couplers, grab irons, etc., Col. Haines proceeds:

"And the congress suggests another field of usefulness for the American Railway Association, — the introduction of American railway methods of construction and equipment and operation on that tripartite continent of which Europe is the smallest member. Of that continent of thirty-three million square miles Europe constitutes but one-ninth in area, and yet Europe is larger than the United States. Of the total railway mileage of the world nearly one-half is in this country, and most of the other half is in Europe. It is to the other great members of the transatlantic continent—it is to Asia and Africa—that I would draw your attention, with their area of nearly thirty million square miles and their population of one thousand million human beings. Is this great field for railroad construction and management to be disregarded by those who are wont to boast of American energy and enterprise? Are we to remain contented with the restricted possibilities for American railway men and for American manufacturers of railway material in the maintenance and operation of roads within our own national boundaries? We are approaching gradually to the conditions which prevail in Europe, where there are more men and larger productive plants than can be profitably employed at home, and we must look abroad for their employment. But it would be a waste of time to seek for opportunities in Europe." "Indeed, Great Britain and the western European States themselves now look abroad for profitable employment for their men, their manufacturers, and their surplus capital. Great Britain has found her field in her own colonies. France has hers in Africa, in Algeria, and Senegal. Belgium has established hers in equatorial Africa, and the Germans, just now outgrowing in productiveness their own needs, are eagerly watching and imitating their British kinfolks. Austria-Hungary, with half our population, is stretching her rails and her trade down the Danube and into the Balkan peninsula.

"In considering this general advance of European countries all along the strategetic line of this campaign for African and Asiatic trade, we may well ask, what will be left for the United States? On the north of us is Canada, British by sentiment, and but partly American in railroad practice. To the south of us is Mexico, where we have some advantage over European methods and appliances; some little opportunity in Cuba and Jamaica, and more perhaps in Central America. Then comes South America, with nearly twice our area and half our population. This is our sphere of action, or, at least, that which will be left to us, if we close our eyes to what is going on elsewhere on the globe. If we wait until fifty miles is built from one African seaport and twenty from another into the heart of that continent, all under the British system, we may say farewell for employment thereafter for any American men in those regions, or for the sale of railway appliances of American make. If French or Belgian or German engineers lay out a railroad line anywhere on the habitable globe, the French or Belgian or German appliances follow, as surely as the thread follows the needle."

"American methods are best suited for

opening up routes on which the traffic has yet to be created. Whatever is best in European practice is best adapted to routes which are intended to furnish facilities for existing traffic. . . . It is not our first-class roads that the projectors in those untried fields can study to advantage. It is the cheap road, the cheap methods of operation, that their interests require, and of which they are ignorant. . . . And it is just here that the value of the American Railway Association comes in,—that is, in pointing out the way for penetrating this ignorance, for dispersing the clouds of prejudice and the fog of indifference which obscure the minds of those European engineers who control the purse-strings of the European capitalists that are to provide the means for constructing the untold thousands and tens of thousands of miles of railroad yet to be built in Asia and Africa and elsewhere, outside of the present limits of American influence. But we must teach by example. Instead of addressing the seven or eight hundred railway engineers and managers that make up the international congress, in a land where there is not one example of American practice, let us induce that great body of men, foremost in railway reputation and experience throughout the world, to come and listen to us here, where every word that we speak will be multiplied in effect one-thousand-fold by what they will find all around them. It is a case in which a great result is to be sought, one of momentous importance to the future welfare of our people, and the effort to accomplish this result must be correspondingly great. Desultory, isolated attempts will fail. Our energies must be concentrated to be effective, and the most effective way to concentrate them can only be afforded by the American Railway Association."

The Question of Cheap Carfare.

UNDER the caption, "Three-Cent Fare Fallacy Exposed," the *Street Railway Review* publishes what the writer styles "an absolutely convincing argument," the "argument" being the subjoined table compiled by the Massachusetts railroad commission.

The *Review* article closes with the statement that "the table explains itself, and constitutes a simply irrefutable argument why a three-cent fare is not only impracticable, but impossible."

	Operating Expenses per Passenger.	Operating Expenses per Car Mile.	Receipts per Car Mile.
Athol and Orange	0310	1338	.2185
Braintree	.0762	2197	.1410
Braintree and Weymouth	.0280	.0659	.1131
Brockton	.0264	1475	.2541
Clinton	.0493	.1624	.1659
Conway Electric	.1534	.2735	.2066
Cottage City	.0306	.1127	.2911
Dartmouth aod Westport	.1400	2678	.3070
Dighton, Somerset and Swan ea	.0473	.2091	.2865
East Wareham, Onset Bay and Pt. Ind	1522	.6302	.5607
Fitchburg and Leominster	.0425	.1544	.2298
Framingham Union	.0395	.1680	.2194
Gardner Electric	.0431	.1912	.2215
Globe (Fall River)	.0309	1616	.2740
Gloucester	0313	.1695	.2726
Gloucester, Essex and Beverly	.0356	.0958	.2509
Gloucester and Rockport	.0369	.3182	.4477
Greenfield and Turner's Falls	.0210	.1176	.2718
Haverhill and Amesbury	.0454	1732	.2754
Holyoke	.0337	.1672	.2703
Hoosac Valley (North Adams)	.0409	.1785	.2387
Hull	.0297	.2098	.3566
Lowell, Lawrence and Haverhill	.0324	.1943	.2983
Lowell and Suburban	.0304	.1263	.2090
Lynn and Boston	.0305	.1603	.2814
Marlborough	.0300	.1201	.1824
Montague	.0241	.0798	.1003
Natick and Cochituate	.0326	.1689	.2644
Newburyport and Amesbury	.0316	.1298	.2064
Newton	.0338	.1720	.2484
Newton and Boston	.0309	.1328	.1777
Newtonville and Watertown	.0385	.1473	.1692
Norlolk Suburban (Hyde Park, etc.)	.0284	.1538	.2464
Northampton	.0282	.1167	.2108
North End (Worcester)	.0530	.1478	.1323
North Woburn	.0459	.1896	.2121
Pittsfield Electric	.0306	.1675	.2804
Plymouth and Kingston	.0377	.1493	.2201
Oulncy and Boston	.0280	.1635	.2852
Rockland and Abington	.0360	.1541	.2099
South Middlesex (Natick)	.0347	.1613	.2297
Springfield	.0330	.1538	.2453
Taunton	.0287	.1312	.2085
Union (New Bedlord)	.0284	.1904	.2943
Wakefield and Stoneham	.0315	.1247	.1964
West End (Boston)	.0363	.2539	.3492
Worcester Consolidated	.0368	.1551	.2512
Worcester and Surburban	.0314	.1826	.2716
Woronoco (Westfield)	.0508	.1539	1534
Average	.0349	.2082	-.3020

It is, however, hard to see how the table can be construed as irrefutably showing anything, except that for the year ending September 30, 1895, it did cost the roads, *on the average*, more than three cents per passenger for operating expenses. There were exceptions, and notable ones. The *Review* weakens their force by stating that, "of the fifty roads, only nine show a transportation cost of less than three cents." To be more exact, of the forty-nine roads, ten show a lower cost; the *Review* writer for some reason overlooks Greenfield and Turner's Falls, .0210, the lowest road reporting. On the other hand, no attention is directed to the enormous and evidently abnormal figures of Braintree, .0762; Conway Electric, .1534; Dartmouth and Westport, .1400; and East Wareham, .1522,—which, of course, tend to unduly elevate the average. A stronger point is made in the statement that, if interest and taxes be included (the writer says they are not in the tabulated figures), no road except the Montague (and perhaps the Greenfield and Turner's Falls?) would show transportation expenses below three cents per passenger.

The *Review* writer sees no way of meeting the lower fares, except through lowered expense secured by reduction of wages. He does not even touch upon the main question, which is: would the lower fare attract such an increased volume of business that the reduction would be more than offset and the gross earnings augmented, while the operating expenses would not be appreciably increased?

For this business is like any other: up to a certain point all of the receipts must go towards operating expenses; after the point of balance is passed, nearly the entire remaining receipts go to dividends and profits. If, under the lower fares, two passengers would ride where one is now carried, or the average passenger would ride twice a day where he now rides once, the road would receive six cents for every five now gathered in, — an increase of twenty per cent. in earnings.

It is extremely doubtful if the increase of expense would be even ten per cent. If not, the road would be the gainer by the change.

The *Review* writer is correct in considering the conditions surrounding the Massachusetts roads "ideal for street-railroading," situated, as they are, in the midst of a dense manufacturing population.

It is, however, debatable whether or not these people "*must* use the cars night and morning" on their way to and from work. The alternative is not, as he suggests, "to keep a horse and vehicle of their own," or to "patronize livery stables to any extent," but simply—to walk.

They *may* use the cars, it is true, and, if the thousands who walk would be induced to ride, and the thousands who ride would be induced to ride oftener, by the three-cent fare, it might be proved neither impossible or impracticable; indeed, it is not inconceivable that its adoption should be the wisest business policy.

The similar but proportionably larger reduction forced upon the New York elevated roads was just as "irrefutably" shown in advance to be "not only impracticable, but impossible"; everyone knows the enormous success with which they have since been operated. The wind is undoubtedly setting in the direction of lower fares, and the railroads will be wise to trim their sails in expectancy of it.

Brine Corrosion of Tracks and Bridges.

THE connection between dressed beef and the destruction of railway bridges seems, at the first glance, a little remote; and yet it is so obvious that the wonder is that it has not sooner excited the attention of railway men. It seems to have remained for the Central Railway Club to bring the matter to general notice by the discussion, at the March meeting, of a committee report upon "Injury Caused by Salt-Water Drippings." The drippings, of course, were from refrigerator cars, and the injury not only to the cars themselves, but to rails, frogs, switches, and bridges.

The startling feature seems to be the extent to which the corrosion has proceeded without any organized effort on the part of the roads to find relief.

The P.C.C. & St. L. notes the "destruction of iron surface cattle guards, and in pipe lines in interlocking switches where they cross tracks. Also annoyance from inability to tighten bolts on switches and frogs." On the N. Y. C. & St. L. Ry., "trouble has been noticed for some time. At points where trains stop regularly, such as terminals, water stations, etc., and wherever brakes are put on, so trains close up and the jar causes water to splash out, rails are found rusted and angle-bars and bolts are rusted 1-16 of an inch thick at joints in some cases. In one case a bridge floor was badly rusted."

The L. S. & M. S. Ry. find the "action of brine is very marked, particularly at points where trains stop and start. Outside splices at many points are badly rusted, and top floor beams and other iron work in floors of bridges are suffering very, very much. . . . They find corrosion confined entirely to east-bound track, which is the one used entirely by the loaded refrigerator cars. Corrosion is found more particularly on lower rail on curves where trains run slowly or stop. . . . Rusted so badly on 1888 pattern of rail in places that base of splice bars is sharp. All bridges, on east-bound track require paint each year to preserve them, while on west-bound track paint on bridges lasts good for a number of years." According to the Lehigh Valley report, salt-drippings were in one case the "direct cause of a broken rail," and generally on the inside of the rail cause splices to "rust away so fast that they soon became too small for the rail, and can not be tightened even with new bolts." The Michigan Central finds the bad effect "notably on the cantilever bridge over the Niagara river," and in some switching yards has had "rails reduced in section from the action of brine."

Many roads concur in noticing aggravated action on the inner rail of curves and the floor beams of bridges; interlocking switch connections suffer severely, as might be expected.

The remedies adopted by the roads seem to be more vigilant inspection and cleaning of exposed structures, and more frequent and thorough painting. The Erie uses hot asphalt paint in the worst places, while the M. C. relies on graphite and the C. B. & Q. on "paint skins and sand put on ½ inch thick."

The Lehigh Valley recommends that "drainage be so arranged as to carry it entirely outside of the rails," and the P. C. C. & St. L. "that cars be arranged so as to prevent drippings"; but on the whole the roads seem strangely tolerant of the evil, and diffident about placing the onus on the owners and shippers of the cars.

The committee, however, is strongly inclined to require the dressed-beef companies to furnish the relief, and makes a recommendation, which it considers "perfectly practicable, for the drips in refrigerator cars to be connected with a reservoir or collector located near the center of car, or at each end over center of track, to hold drip until trains reach terminals or elsewhere, when reservoir can be emptied by trainmen or inspectors." They add minor details to meet the possible objections, and enforce the necessity of a radical change by citing recent wrecks due to the breakage of brake-beam hanger-eyes, rusted through by salt drippings.

Safety as well as economy would seem to demand that the railroads should prohibit the wholesale scattering of corrosive liquid along their permanent way, and the power, as well as the right, to enforce a remedy appears to rest in their own hands.

THE Orleans Railway, France, says *Engineering News*, reports great success in suppressing dust from sand-ballast by covering the roadbed with a 2½ inch bed of broken stone. It is said that the cost is one-fourth that of stone-ballasting, and that large saving to rolling-stock results from suppression of dust.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Railroad and Engineering Journals—See Introductory.

*5266. Are British Railroads Good Investments? Thomas F. Woodlock (Showing the ratio of capital to revenue and of operating expenses to earnings in the administration of British railroads, and maintaining that the decreasing percentage of dividend and the steady increase in operating expenses point to a decline of confidence in the security of British railroad shares). Eng Mag–May. 4700 w.

*5292. Snowdon Mountain Railway (A full description from the historic, descriptive and technical standpoints, with map, profile and eight fine half tones from photographs of scenery). Engng–April 3. Serial. 1st part. 3700 w.

*5297. Train Resistance. Angus Sinclair (The text-book formulæ impugned and evidence of their inaccuracy furnished. Incidentally the fast run on the L. S. & M. S. is defended against attacks based on theoretical calculations). Engng–April 3. 1500 w.

5299. Empty Car Mileage (Editorial review of A. E. Mitchell's paper before the New York R. R. Club on the "Large Car Problem"). R

R Car Jour–April. 500 w.

5300. Air Brake Hose Dummy Couplings (Editorial reviewing the defects of common practice and suggesting a remedy). R R Car Jour–April. 250 w.

5301. Air-Brake Testing and Inspecting Plant (Editorial review of the report of the Committee on Air-Brake Testing and Inspecting Plants. An extract is given embodying the recommendation as to inspection and testing in interchange yards and elsewhere). R R Car Jour–April. 500 w.

5302. Examination of Car Inspectors (A symposium of correspondence, chiefly commendatory). R R Car Jour–April. 1800 w.

5303. M. C. B. A. Arbitration Cases (A full tabulation of cases submitted, won and lost by the various roads and companies). R R Car Jour–April. 500 w.

5304. M. C. B. Association Standards and Recommendations (An abstract of the recent M. C. B. A. circular embodying suggestions received and recommendations adopted by the committee to date) R R Car Jour-April. 1000 w.

5305. Piece Work in Car Shops. G. L. Potter (A paper read before the Western Railway Club. A discussion of the application to repair work especially, the conclusion being strongly favorable to the system. The paper embodies illustrations of actual practice and of the forms in use in standard car shops). R R Car Jour–April. 2300 w.

5306. Combination Ore Car: Duluth, South Shore and Atlantic Ry. (Descriptive text and full drawings). R R Car Jour–April. 900 w.

5307. The Social Circle Decision (Editorial calling attention to the limited scope of the decision and the error into which the press generally has fallen in giving it too wide an interpretation). Ry Age–April 11. 1000 w.

5309. Employés on Government Railways.—The Rules and Regulations in Force on the Government Railways of Australia. Alfred C. Fraser (A brief introductory note commends the article to attention on account of its interest in connection with the agitation for government ownership of railways in this country). Ry Age–April 11. 3300 w.

5310. Electricity on Elevated Roads (The change from steam to electric power being made on the Lake street road in Chicago). Ry Age–April 11. 800 w.

*5311. Through the Baltimore Tunnel on an Electric Locomotive. Ill. A. M. B. (Describing the power plant, the general arrangement and practical working). Ry Wld–April. 1500 w.

*5312. Notes on Austrian and Italian Railways (The first paper contains detailed reports of single English and French runs, and general observations on fares, equipment and station accommodations in Austria. Passing mention is made of the steepest adhesion railway in Europe—that to the summit of the Uetliberg). Ry Wld–April. 1200 w.

*5313. Rouen Electric Tramways (Descriptive of the power installations, buildings, construction of the line, rolling-stock, cost of erection and rates of fare). Ry Wld–April. 2800 w.

*5314. Improved Tramcar Lighting (An English opinion of the New York situation, gleaned from the local press. Contains an interesting comment on the effect of good lighting upon volume of travel). Ry Wld–April. 250 w.

*5315. The Vulcan Foundry and its Early Engines. Clement E. Stretton (A list of early English engines, with partial measurements). Ry Wld–April. 800 w.

*5316. Storage Battery Traction at Birmingham (Described as being quite satisfactory to the public and very unprofitable to the companies). Ry Wld–April. 600 w.

*5317. Newspaper Comment on Electric Traction (Indicating the status of the overhead wire question in London). Ry Wld–April. 600 w.

*5318. The Stanzerhorn Cable Railway (Brief description of a steep inclined road). Ry Wld–April. 450 w.

5323. Profiles of the Principal Mountain Railways of the World (Chart superimposing European, South American and U. S. mountain lines, with brief explanatory comment). Eng News–April 9. 400 w.

†5334. Air Brake Testing and Inspecting Plants (Full report of Committee to the Central Railway Club). Pro Cent Ry Club–March. 2000 w.

†5335. Stenciled Light Weight of Cars (Central Railroad Club Committee's report and discussion of change in car weights, and means of checking). Pro Cent Ry Club–March. 4000 w.

†5336. Injury Caused by Salt Water Drippings (Rather startling report of injury to cars, track, bridges, etc., from the salt drippings from refrigerator cars). Pro Cent Ry Club–March. 3000 w.

†5337. Hot Boxes and Their Cause (Causes of hot boxes discussed, experiences compared and remedies proposed). Pro Cent Ry Club–March. 5000 w.

*5343. Electric Traction on Rack Railways. Frank B. Lea (The advantages are set forth, and several noted lines are briefly described). Elec Eng, Lond–April 3. 2000 w.

*5350. Light Railways: Their Advantages, Nature, and Working (An article on their importance, and quoting freely the statements made by Mr. Brewer). Ill Car & Build–April 3. 1100 w.

5357. Electricity on Trunk Railroads. William Baxter, Jr. (The writer thinks it has been fully demonstrated that electric motors are capable of handling the heaviest traffic, and if the saving in operating expenses should prove to be below that of steam, at least new roads would use electricity). Sci Am–April 18. 1200 w.

5373. Some of the Difficulties in Designing Rail Sections. P. H. Dudley (A letter from a well known expert in rail designing, describing the difficulty of designing a rail section so that it will roll well and will have the specified weight). R R Gaz–April 17. 800 w.

5374. Three-Position Signals and Permissive Blocking. J. W. T., Jr. (A word in defense of permissive blocking). R R Gaz–April 17. 400 w.

5375. The Uses of Momentum Grades. William G. Raymond (A letter discussing some of the features involved in the theory and practice of using the momentum of the train in surmounting grades). R R Gaz–April 17. 1100 w.

5376. 60,000-lb. Coal Car, Southern Railway (Detail drawings with dimensions). R R Gaz–April 17. 200 w.

5377. The World-Wide Field for American Railroad Men (Condensed address of Col. H. S. Haines, President of the American Railway Association, at Cincinnati, April 15, drawing attention to wide field for railroad work in Asia and Africa). R R Gaz–April 17. 1800 w.

5378. The Philadelphia and Reading Railroad Subway and Tunnel in Philadelphia. Walter Atlee (A brief description of the great project for separating the street grades and the grades of the Phila. & Read. R. R). R R Gaz–April 17. 900 w.

5379. Air-Brake Piston Travel (A report on the effects of air-brake piston travel and the limits which should be set to that travel. Made by a committee of the Air Brakemen's Asso). R R Gaz–April 17. 4000 w.

*5392. The North Wales and Liverpool Railway (An important link in the Welsh Railway system and a notable drawbridge). Trans–April 3. 2700 w.

*5394. The Railways of Rhodesia (A very brief note of the present conditions). Trans–April 3. 200 w.

5403. The Scranton Traction Company (Illustrated description of plant, buildings and equipment, including also the connecting Carbondale Traction Co.) Elec Ry Gaz–April 10. 1400 w.

5404. Maintenance of Rolling Stock. C. E. Ubelacker (Suggestions as to inspections, and repairs, with illustrations of tools and devices). Elec Ry Gaz–April 10. 2300 w.

5405. Cable vs. Electric Traction (Editorial argument for electric traction based on accidents due to the breakage of cable strands). Elec Ry Gaz–April 10. 300 w.

5406. The Street Railway Company Must Complete Its Contract (Summary of a decision affecting the rights of a passenger to transfer around a blockade without paying a second fare). Elec Ry Gaz–April 10. 300 w.

*5416. Pleasure Resort Roads (A list of the principal roads of this character, with brief description and illustrations of their attractions. The topic is treated with reference to its relation to travel and income). St Ry Rev–April 15. 3000 w.

*5417. Power House Performance (Tabulation of results of twenty plants, with comment on condensing engines and economy of condensing water). St Ry Rev–April 15. 800 w.

*5418. Conductorless Roads (A list of roads operated wholly or partly without conductors. Editorial comment calls attention to the smallness of the number and the generally poor economy of the practice). St Ry Rev–April 15. 900 w.

*5419. Counterweight System at Providence, R. I. M. H. Bronsdon (The application of the system to a difficult case is illustrated by plans, photographs, and explanatory text). St Ry Rev–April 15. 700 w.

*5420. Preservation of Wooden Posts (Stone ware cover suggested as a protection at the ground line for posts used for carrying electric wires, etc). St Ry Rev–April 15. 300 w.

*5421. Interurban Express at Binghamton, N. Y. J. P. E. Clark (Introduction of express and freight service on an electric road is described, with illustrations of the combination car employed). St Ry Rev–April 15. 1200 w.

*5422. A New Method of Testing Rail Bonds. Harold P. Brown (Description of a new method employed on the Niagara Gorge Road, with comment on the extremely satisfactory results determined). St Ry Rev–April 15. 600 w.

*5423. A German Substitute for Guard Wires (Illustrated description of a device which is recommended as securing entire efficiency with reduced cost). St Ry Rev–April 15. 600 w.

*5424. Earnings and Operating Expenses of Connecticut Street Railways (Detailed reports from twenty railways). St Ry Rev–April 15. 1300 w.

*5425. Lake Street Elevated Motor Cars and Shops (Brief description with photographs). St Ry Rev–April 15. 250 w.

*5426. Standard Electrical Rules Relating to Street Railways (This is a communication from Frank R. Ford, representing the American Street Railway Association, presenting the rules at present adopted and asking for suggestions as to revision). St Ry Rev–April 15. 1000 w.

*5427. Development of Electrical Traction Apparatus (A review of the American Field, abstracted from Mr. H. F. Parshall's paper before the Foreign and Colonial Section of the Society of Arts, in England. It contains some points of current interest and information to American electric railway men). St Ry Rev–April 15. 1200 w.

*5428. Three-Cent Fare Fallacy Exposed (A review of the report of the Mass. R. R. Commission, showing that on every road in the State the operating expenses exceed 3 cts. per passenger. The writer concludes that this demonstrates the impossibility of a 3 cts. fare). St Ry Rev–April 15. 1100 w.

*5429. Life of Rails under Electric Service (A compilation of reports from various roads). St Ry Rev–April 15. 1100 w.

5443. Demurrage Legislation (Full text of a bill introduced in the Ohio legislature designed to enforce demurrage charges against railroads as well as shippers and consignees). Ry Rev–April 18. 1000 w.

5444. Qualifications of a Superintendent of Air Brakes (A paper read by F. B. Farmer before the Northwest Railway Club. Prefacing the author's estimate of qualifications by a summary of reasons demanding the existence of such an official enforced by instances from experience). Ry Rev–April 18. 1800 w.

5445. The Electro-Pneumatic Interlocking Plant at Grand Avenue, St. Louis (Description with plan of tracks and signals, cuts of the machine, sample charts of lever locking and dog-shed). Ry Rev–April 18. 2000 w.

5446. Transportation From an Operating Standpoint. D. S. Sutherland (Read at the meeting of the Toledo Asso. of R. R. Officers. Calling attention to the failure to effect, in yards and terminals any such improvement as has been made in every other department of R. R. service). Ry Rev–April 18. 800 w.

5447. Electrical Equipment — Mt. Holly Branch Pennsylvania R. R. Calvert Townley (Paper read before the New England R. R. Club, describing the partial application of electric traction to a road formerly wholly operated by steam). Ry Rev–April 18. 1000 w.

5448. Shop Notes Atchison, Topeka & Santa Fé Ry., Topeka, Kan. (Describing some interesting points of practice and economy in a practical and progressive shop). Ry Rev–April 18. 2800 w.

5453. The Influence of Braked Trains on the Superstructure of Metallic Bridges. F. Jasinski (Abstract of an article in the *Revue Generale des Chemins de Fer*, July, 1895, expressing the belief that strain from this cause is frequently overlooked, showing by example its importance, and suggesting a simple plan of resisting bracing). Ry Rev–April 11. 900 w.

5454. Track Elevation, N. Y., N. H., & H. R. R. in Boston (Data, drawings, diagrams, and general specifications of four track skew bridge). Ry Rev–April 11. 1200 w.

5455. Uniformity in Semaphore Signals (Editorial on a new rule adopted by the Pennsylvania Co., commending the practice). Ry Rev–April 11. 400 w.

5456. The Import Rate Case (Substance and major portion of U. S. Supreme Court opinion in the matter of through rates on freight shipped through a port of entry to an interior point, with editorial). Ry Rev–April 11. 10300 w.

5512. K. A. K. Conduit Electric Railway System (A system that has excited much attention in the west. It is a trolley conduit system and has a line of railway in operation in Springfield, O). W Elec–April 25. 800 w.

5515. A Ride on a Compound Locomotive and Other Matters. F. W. Dean (A communication devoted chiefly to comment on the relative value of fire-box and boiler-tube heating surface). R R Gaz–April 24. 600 w.

5517. The Air-Brake Men's Association (Full committee reports on the water raising system in sleeping-cars and the economical lubrication of air-brake cylinders). R R Gaz–April 24. 4800 w.

5518. Compound Switching Locomotive (Engravings and specifications, illustrative and descriptive of six-wheel connected compound locomotive for making up trains in the Grand Central Station at New York). R R Gaz–April 24. 1000 w.

5519. Brake Slack Adjusters (Committee report before the Air-Brakemen's Association, embodying the results of experience with adjusters, and recommendations as to construction, location, setting and general practice). R R Gaz–April 24. 1800 w.

5520. The Baltimore and Washington Electric Railroad (Brief description with sketch map of line and summary of progress made). R R Gaz–April 24. 1200 w.

5521. The Zone Tariff in Hungary (An editorial review of the proposed reform, giving the distance, fares, and a summary of the contemplated change which is expected to result in considerably increased revenue). R R Gaz–April 24. 500 w.

5522. A Free Cartage Decision (Review of an Inter-State Commerce Commission order prohibiting free cartage by the D., G. H., & M. railroad at Grand Rapids, and of a circuit court decision affirming the order, with an editorial discussion strongly urging the demoralizing influence of the practice). R R Gaz–April 24. 1400 w.

5523. Boiler Explosion at Bridgeport, Ala. (Brief illustrated account of an unexplained locomotive boiler explosion on the N., C., & St. L. Ry) R R Gaz–April 24. 150 w.

5524. Train Accidents in the United States in March (A summary of the accidents of the month with their causes and results). R R Gaz–April 24. 2300 w.

*5542. Some Recent Features of Permanent Way (Review and comment upon increased rail length trials and other recent experiments and innovations in practice, designed to increase the life of rails). Ir & Coal Trs Rev–April 10. 3200 w.

*5543. The Use of Iron and Steel for Railway Sleepers (A summary of the European situation, with some notes of current practice, and of results experienced. The conclusions drawn are non-committal, but inclined to be favorable). Ir & Coal Trs Rev–April 10. 1800 w.

*5544. The Construction and Supply of Rolling Stock (The article is almost entirely devoted to a discussion of the comparative merits of the English goods waggon and the American freight car, with the conclusion that each type is probably best suited to its own surrounding conditions). Ir & Coal Trs Rev–April 10. 1200 w.

*5545. Electric v. Steam Railways (A rambling mention of various features of American and European enterprise construction, with comparative tables of operating expenses on the Liverpool, Manhattan and Brooklyn Elevated roads in 1892 & 1893). Ir & Coal Trs Rev–April 10. 1600 w.

*5546. Railway Workshops and Their Equipment (An argument for the importance of having the best tools, and some suggestions for practical mechanical devices and handy appliances for shop use. The ideas are largely drawn from American practice). Ir & Coal Trs Rev–April 10. 2500 w.

SCIENTIFIC MISCELLANY

The Dudley "Powder-Pneumatic" Gun.

THE accident which occurred at the recent trial of this gun, in which a shell prematurely exploded, has, it is said, demonstrated no defect either in the principle or construction of the weapon. It has shown only the defective character of the type of fuse used for igniting the shells. As the method of obtaining a high pressure quickly in a considerable mass of air, which underlies the action of the gun, seems capable of extension to useful industrial purposes, we present here an abstract of the description given in the *Scientific American* (April 25).

Gunpowder, when burned behind a projectile in a gun, acts upon the projectile to move it forward exactly as steam acts upon a reciprocating piston, except that the inertia of the projectile, its friction in the gun-barrel, and external air pressure are the only elements of resistance in the gun, while in the steam cylinder there are added to these elements the friction and inertia of other moving parts at all times, and the mechanical work performed by the engine upon that which constitutes no part of its structure. The mere fact that far higher pressures are practicable in guns than in engine cylinders is a distinction of degree only; the main principle of action is precisely the same for both. The pressure of a confined gaseous body upon an inert mass is the immediate origin of power and of work performed by each.

In the steam engine the gas of water, produced under pressure in the boiler, is the immediate agent; in the ordinary gun, the gas produced by the powder is the immediate agent. In pneumatic guns, air compressed by some means (usually by a machine called an air-compressor) is what moves the projectile. In the Dudley "powder-pneumatic" gun, machine compression is avoided, and the compressed air is at once obtained by the explosion of gunpowder, thus dispensing entirely with the ponderous air-compressing machinery hitherto used, and adapting the gun to field-service.

Gunpowder has been previously used to generate power in mechanical operations other than the throwing of projectiles and the blasting of rocks. The gunpowder pile-driver has been, perhaps, the best known of these applications. But it is the particular method of gaining the store of compressed air in the Dudley system that is suggestive of applications in other fields. In the gunpowder pile-driver, and other attempts to utilize the gases of gunpowder as a source of mechanical power, no storing-up of power has been accomplished. In the method employed by Dudley, the compressed air may be held indefinitely for future use. The practical advantages of this feature of the invention will suggest themselves at once to all mechanics.

"Three tubes constitute the principal elements. These lie parallel to each other. A long central tube is the firing tube. The two side tubes are connected by an air passage at their forward ends, which ends are closed. The rear end of the left-hand tube, also closed, is connected to the rear end of the central barrel or firing tube. The right-hand tube and the firing tube have breech mechanism, like that of a breech-loading rifle.

"The action and manipulation of the piece is simplicity itself. A metallic powder cartridge is inserted into the rear end of the right-hand tube, and its breech is closed. A torpedo is placed in the central tube, whose breech is then closed. The powder is fired. The air in the tubes is compressed by the gases generated from the explosion, the pressure rising to eight hundred and fifty pounds. The force of the explosion, cushioned by the two columns of air intervening between the powder and the projectile in the central tube, acts upon the projectile. With a slight noise and without a particle of smoke or flame the projectile is driven out of the barrel and passes smoothly through its trajectory. About the same effect is attained as with the regular pneumatic gun. The extensive air-compressing plant of the latter is, in the case of the Dudley gun, represented by a simple blank cartridge."

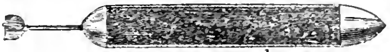
The safety attachment to the Merriam fuse used with the projectiles is a very ingenious device. The figures illustrating projectiles, herewith reproduced, are almost self-explanatory.

"The Merriam fuse operates by inertia or by direct impact. If the shell strikes the water, the inertia operates the ignition. A steel ball within it is driven forward, owing to the retardation of the motion; and the ball, by striking, causes the detonation of one or more percussion caps, three being used to insure firing. The ignition of a tube of slow-burning powder is thus effected, which communicates with the fulminating mercury and so explodes successively the gun-cotton and the main explosive in the shell. The period of the explosion is determined by the slow-burning powder; by altering it, the time element can be regulated with the greatest accuracy.

"For attack upon armor, instant detonation is required, and this is secured on the direct-impact principle, by crushing in of the head, and the driving back of one to three firing pins, which ignite quick-burning powder, the fulminate, the gun cotton, and the main explosive in instantaneous succession.

"The element of safety is introduced in the Merriam fuse by a little windmill, or vane, on the front of the fuse. This is inclosed in a recess, whence it escapes as the shell leaves the gun, and instantly begins to turn, actuating a screw which has been screwed down upon the firing ball. After the shell has traveled a few hundred feet, the ball is free to work the instant the shell is arrested in its flight.

"Fig. 1 shows the service shell packed with high explosive, the fuse vane being concealed within the forward cone. The rear cone is of aluminum. Fig. 2 shows a practice cone charged with gunpowder, lead ballasted, and with the fuse vane shown projecting from its forward end. It was with a shell of this type that the accident occurred. Figs. 3 and 4 are simple non explosive practice shells, one of wood, the other of metal. The ballasting of the projectiles is of the greatest importance, as their steadiness of flight depends on the center of gravity being in a definite place."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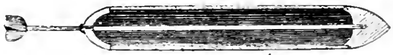
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The gun weighs about a ton, including the mount, and, it is said, is capable of throwing shells weighing thirty-two pounds, with an initial velocity of seven hundred feet per second. The recoil is very slight.

Steel Tanks for Storing Grain.

THE preservation of food products (of which wheat is by far the most important to the human race, taken as a whole) is a matter of prime importance. In some less-favored countries years of what would be utter famine are bridged over by provident wisdom in this way. Jnanendra Narayan Ghose, in *The Arena* for May, speaks of the famines that have occurred in India, and tells us that, when Mysore was under British rule, neglect of English officials to provide a store of water for irrigation in the years 1876-77-78, when the seasonal rains failed, caused one-fourth of the native population to perish from scarcity of food. This, he further says, was the result of pure neglect, "for so complete and admirable is the tank system of Mysore that famine is impossible," if proper care be exercised. What he thus calls tanks we should call reservoirs, and they are very numerous in Mysore. There are, according to this writer, thirty-eight thousand of them, varying in size from small ponds to extensive lakes. In the years above stated many of these had been allowed to become almost useless through neglect. It is thus seen that emergencies may arise when stores of food become of much more than ordinary importance, and even in favored lands such stores are needful to insure the proper preservation and distribution of food to the people. Anything that favors these desirable ends is a boon to the human race, and also to the large animal dependency which is under the care of, and receives its sustenance from, the hand of man.

The steel-tank system of grain storage appears to combine all essentials for the preservation of cereals for indefinite periods. Injury by fire, moisture, or vermin seems completely provided against, and the lateral pressure, analogous to hydrostatic pressure, in a deep mass of grain is most completely restrained by the cylindrical form, so that very large masses of well-cured grain may be stored on a small area of ground,—an important consideration in large cities, where land is very valuable.

American Miller (May 1) publishes an illustrated description of some steel tanks erected at the Manhattan Mill at Toledo, Ohio, which are used in connection with the so-called "pneumatic system" of conveying grain, by which the grain is cooled and either delivered into the storage tanks (which loom up much like large gas-holders) or taken from the tanks into the bins of the mill, as desired for milling.

"The pneumatic machinery is located on the fourth floor of the mill building, the grain being conveyed to this point by an ordinary elevator, from which it is spouted into an air-tight steel receiver, to which one of the P. H. & F. M. Roots Co.'s positive blowers is connected by an air pipe on the dome. Power is transmitted by two belts direct to the blower. Upon entering this receiver, the grain drops of its own weight to the bottom, from which it is fed through an automatic feed device into the blast current, which carries it from the mill to the tanks, entering them at the top.

"In bringing grain from the tanks to the mill the current is changed by manipulating two valves, from that of a blast to a suction, closing a valve on top of the tanks and opening one on a pipe leading down between them, at the end of which is a peculiar shaped mouthpiece, resting on the bottom of a metal sink. The air is admitted at this point by opening the ou - let slides on the bottom of the tanks, and the grain rushes into the sink, where it comes in contact with a strong suction current. The ascending column, on leaving the chamber of the mouthpiece, assumes the rotating motion, and the grain is carried up in the direction of a winding inclined plane, similar to that observed in the whirlwind. As the grain enters the receiver, it drops by its own gravity to the bottom of the receiver, and aga'n it is fed through the automatic feed device, from which it is spouted into the mill bins. The simplicity of the machinery is such that little or no attention is given it while in operation."

The extreme vertical lift is fifty-five feet. The horizontal pull is two hundred and fifty feet. An engine of about twelve horse power is said to be sufficient for handling the grain rapidly. The capacity of each of three tanks erected for the mill above named is twenty thousand bushels. This method of storing and handling grain bids fair to go into very extensive use.

A Well-Won Honor.

"Dr. Wm. H. Wahl, for many years resident secretary of the Franklin Institute, has been honored by the French government by election as 'Officier d'Académie,' with the decoration of the 'palmes académiques,' in recognition of his labors as secretary of the leading institute in America devoted to the advancement of the arts and manufactures, and of services rendered to the French government." Those who have the honor of a personal acquaintance with Dr. Wahl, and those who know the influence he has exerted upon scientific and material progress, will accord with us in the opinion that this high honor has been well-merited and worthily bestowed.

In an article entitled "Comparative Merits of American and Foreign Cements" *Engineering News* (May 7) shows conclusively that no nation has the monopoly of manufacturing good cement, notwithstanding what it calls "the superstition concerning cement among engineers"; and "that the reputable brands of cement appear to be of about the same quality in one country as in another."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Scientific and Engineering Journals—See Introductory.

*5263. Quackery in Engineering Education. Edgar Kidwell (Showing the falsity of the claims and the inadequacy of the methods by which technical schools and professors secure and train students). Eng Mag–May. 3700 w.

5272. Diffusive Reflection of Röntgen Rays. M. I. Pupin (Presented before the New York Academy of Sciences. A brief description of a series of experiments with Röntgen radiance which were recently conducted. The most important results refer to diffuse reflection or scattering of Röntgen radiance). Science–April 10. 3500 w.

5273. How Nature Regulates the Rains. R. L. Fulton (A discussion of the question of the relation of plant life to water supply. The building of railroads and opening of mines in the west, thus destroying the forests, have led to the conclusion that nature has storage facilities capable of resisting all that man may, or may not, do. An interesting paper). Science–April 10. 4500 w.

†5277. The Mushroom Industry in France (Description of the cultivation of mushrooms, as conducted in various parts of France, and of the different modes of packing and preserving them for market. It is estimated that a capital of 40,000,000 francs is invested in this industry in Paris alone). Consular Reports-March. 7800 w.

†5278. Cotton Mills of Japan (Statistics, giving number and names of mills and the quantity and value of their output in 1892, with reference to the development of cotton manufacturing in the far east). Consular Reports–March. 1000 w.

†5279. Belgian Damascus Gun Barrels (Description of the processes of manufacture, and statement of the magnitude and importance of the industry). Consular Reports–March. 1500 w.

*5344. The New Process for the Liquefaction of Air and Other Gases (Descriptive of a new apparatus, and its use. The results attained are of high scientific interest). Nature–April 2. 1000 w.

5353. Are Roentgen Ray Phenomena Due to Sound Waves? William A. Anthony, with Editorial and brief article by Thomas A. Edison (Mr. Anthony does not favor Mr. Edison's idea that the Röntgen ray may be sound waves. The editorial reviews the theories thus far advanced). Elec Eng–April 15. 1800 w.

5354. Producing Röntgen Rays Under Novel Conditions. E. W. Rice, Jr. (Interesting experiments made by the writer). Elec Wld–April 18. 900 w.

5355. The Source of the Röntgen Rays. Clarence I. Cory, J. N. Le Conte and R. W. Lohman (These experimenters conclude that the source of the Röntgen rays is the solid upon which the cathode rays first strike, giving up either partially or entirely their negative charge). Elec Wld–April 18. 2200 w.

5358. Magnetographs Made by Radiations from the Poles of a Magnet. John S. McKay (Experimental indications that the Röntgen effects may be due to the magnetic component of a Hertz wave, suggesting also that the Röntgen rays may themselves be something analogous to these magnetic rays). Sci Am–April 18. 800 w.

5362. Proposed Standard Tube for Producing Roentgen Rays. Elihu Thomson (Illustrated description). Elec Rev–April 15. 500 w.

*5369 Röntgen Rays. Max Osterberg (Paper prepared from a lecture delivered by the author before the N. Y. Electrical Society. It is accompanied by portraits of Faraday, Hertz, Crookes, and Röntgen). Elec Pow April. 5000 w.

5380. The Flow of the Connecticut River. Dwight Porter (Read before the American Forestry Association. Observations taken at Hartford and Holyoke are examined for the purpose of seeing whether they reveal any changes in the character of the flow which could be ascribed to the cutting of the forests. The writer finds no permanent change). Science–April. 1000 w.

5382 On the Best Shape for the Röntgen Ray Tube. W. M. Stine (A short discussion of tube designs with an illustration of the one the writer has adopted as a standard). W Elec–April 18. 600 w.

*5435. The X-Radiation: Interview with Mr. Jackson (Some account of the work accomplished by this experimenter). Elec Rev, Lond –April 10. 2000 w.

*5437. Further Progress in Radiography. Oliver Lodge (An interesting review of experiments, both in their application to surgery and anatomy, and in determining the physical nature of the rays). Elect'n–April 10. 3700 w.

5485. Roentgen Ray Diffusion and Opalescence—A Novel Phenomenon. Elihu Thomson (Describes the phenomena of diffusion of Roentgen rays by certain classes of substances in such a way that such substances must be regarded as opalescent). Elec Rev–April 22. 900 w.

5486. Tesla's Latest Roentgen Ray Investigations (A communication from Nikola Tesla giving an interesting account of his scientific work in this field). Elec Rev–April 22. 4500 w.

5495. Kinematics of the Roentgen Ray. W. M. Stine (Discussing refraction, reflection, difraction, and interference). Elec Eng–April 22. 1300 w.

5496. Influence of Temperature on X-Ray Effects. Thomas A. Edison (Experiments made by writer). Elec Eng–April 22. 500 w.

*5499. Pyrometers, and Their Application (Notes of an address by Dr. Mohlke to the Polytechnic Society of Berlin Treats of pyrometers based upon expansion by heat of those based upon expansion by liquids, such as are based upon expansion of gases, those giving indications by radiation of light, of electrical methods, and calorimetric methods of determining high temperatures, and of definite temperature methods. It is compiled from information collected by the Imperial Physical Technical Institute, and relates to methods in use in German industrial arts). Gas Wld–April 12. 1300 w.

5500. The Dudley Powder Pneumatic Gun (An excellent, clear, detailed and illustrated description of the construction and use of this new weapon). Sci Am–April 25. 1400 w.

5513. Notes on Röntgen Rays. H. A. Rowland, N. R. Carmichael, and L. J. Briggs (A communication somewhat modifying their statement is published in the *American Journal of Science*, with account of further study in this field). Elec Wld–April 25. 1000 w.

*5557. The Electro-Chemical Company's Works at St. Helens (Illustrated general description of works, apparatus and process for resolving, by the electric current, common salt into soda and chlorine gas). Eng, Lond–April 10. 2000 w.

*5587. The Roentgen Rays. Henry Morton (States facts long known which in some cases seem to have been forgotten, and points out the true characteristics of Roentgen's discovery). Engng–April 17 2800 w.

*5588. The Metric System (A sharp criticism upon articles in the *Times* (London), charging that paper with criticising the decimal system, which, it is claimed, is by no means the same as the metric system. The decimal system is regarded as a mere incident of the metric system, since the meter might have been divided into eighths or twelfths, as well as into tenths. The duodecimal system is considered as more convenient than the decimal system, but in spite of some inconveniences the decimal system prevails, and there has never been any serious intention of altering it). Engng–April 17. 2500 w.

5640. The Use of the Röntgen X Rays in Surgery. W. W. Keen (An illustrated description of the method of investigation, with a statement of the difficulties and cautions against too hasty conclusions, closing with a summary of conclusions as to the present value of the method). McClure's Mag–May. 5000 w.

*5647. Suggestions for a Duodecimal System of Notation, Weights and Measures. G. Halliday (An article condemning the metric system, and suggesting the use of 12 as a base for a system and endeavoring to show that no very radical change is necessary for the adoption of such a system). Elec Eng, Lond–April 17. 2800 w.

5682. Apparatus for Measuring the Speed of Projectiles (Illustrated description of an instrument designed to measure very minute intervals of time developed at the United States Artillery School and used for measuring the velocity of projectiles from the new 3 2 inch B. L. field rifle adopted by the army). Sci Am–May 2. 1300 w.

5683. The Royal Observatory and How They Tell the Time at Greenwich (Illustrated description of a world famed observatory, and methods by which "Greenwich time" is determined). Sci Am–May 2. 1600 w.

5684. Bacteria In Milk. By H. W. Conn, of the Biological Department Wesleyan University, in the *Spatula* (The effects of bacteria in milk, as related to cleanliness in the procuring of milk from cows, and in the care bestowed upon it subsequently). Sci Am–May 2. 1800 w.

*5689. Photographing the Unseen—A Symposium on the Roentgen Rays. Ill. (The contributors to this symposium are Thomas C. Martin, Editor of the Electrical Engineer; R. W. Wood, Berlin, Germany; Elihu Thomson, Lynn, Mass; Sylvanus P. Thompson, London, Eng; J. C McLennan, Univ. of Toronto; William J. Morton, New York, and Thomas A. Edison, all noted as able electricians, and some of them of world wide fame as physicists. What they have to say of the past, present and probable future of this new field is of great interest). Century Mag–May. 6000 w.

*5697. Professor Roentgen's Discovery and the Invisible World Around Us. James T. Bixby (A broad general discussion of this discovery in its relations to the already explored, and the yet unexplored, fields of science). Arena–May. 6800 w.

*5727. The Life History of an Ocean Wave. W. F. Durand (A study of the question how wind acting upon water gives rise to waves, a question never yet satisfactorily answered in detail). Sib Jour of Engng–April. 2200 w.

†5744. Röntgen Rays not Present in Sunlight. M. Carey Lea (Describes experiments which appear to demonstrate that, contrary to what some have supposed these rays are not found in sunlight, and also that they are not present in the radiations of the Welsbach light). Am Jour of Sci–May. 700 w.

5757. How to Make and Use a Simple Spectro Photometer. W. H. Birchmore (Illustrated detailed description). Pro Age–May 1. 1100 w.

5758. Carbide of Calcium and Acetylene, and Their Applications. Ed. Hospitalier (Abstract of a paper read before the Société Internationale des Electriciens. The properties of calcium carbide and of acetylene occupy a considerable part of the paper, which concludes with a review of the present and probable applications of acetylene). Pro Age–May 1. 1200 w.

5762. Southern Pine—Mechanical and Physical Properties (Relating to investigations carried on by the Division of Forestry in the laboratory at St. Louis, under J. B. Johnson and in the laboratory at Washington, by Filibert Roth. The data presented are condensed from not less than 20,000 tests, and a similar number of measurements and weighings). U. S. Dept. of Agri—Circ. 12. 5800 w.

THE

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THE CAUSE AND REMEDY FOR BUSINESS DEPRESSION.

By Edward Atkinson.

I HAVE been asked by the editor of the ENGINEERING MAGAZINE to review "the present conditions of business" in this country, and to point out the causes by which our progress in material welfare has of late been retarded. The terms of this request are in the following words: "An appeal to business men is called for, to sweep away the interference of the politicians."

It is not difficult to deal with the present condition of business, and it is easy to denounce the misdoings of politicians in general terms. No remedy will be found, however, for the evils under which we are suffering, until the definite source of the admitted depression and distrust is reached and the remedy applied. We may denounce political action; yet neither confidence or credit can be fully restored without legislative action, which implies political action. It is admitted by politicians of all types that the sources of present distrust and discredit by which what is called "the business of the country" is retarded are to be found in political and legislative action in the past. The remedy has in part been found in the repeal of an act of congress known as the Sherman act, and may yet be found in the repeal of other bad acts rather than in the enactment of new statutes.

The invention of money preceded the invention of coinage. After that invention had been placed at the service of mankind in an early period in economic history, it became evident that the precious metals, so-called,—silver and gold,—had become by natural selection the money metals, displacing cattle, skins, copper, iron, and other valuable articles which had previously served the purpose of money. After public coinage had displaced private coinage,—the object of rulers in assuming the function of coinage being at first to assure just and equal weight and quality in every coin,—legislation, or the decree of rulers, began to affect monetary conditions.

Under the pretext of a coinage act an effort has been made to force silver into use as money without regard to its bullion value, beginning with the so-called Bland act of 1878, followed by the so-called Sherman act of 1890, now culminating in the demand for free coinage of silver into dollars at the ratio by weight of sixteen of silver to one of gold. The promoters of these acts propose to force the people of this country to accept dollars made of silver costing only fifty to sixty cents each as a legal tender in place of dollars made of gold or its equivalent.

That such an act of force or legal tender is wholly without warrant and uncalled for is proved by all the conditions of international commerce. There is no international act of legal tender. The object of the so-called bimetallic treaty is simply to bring the force of a legal-tender act into international commerce, which is now free from any such compulsory measure. The whole commerce of the globe, nation with nation and section with section, is conducted in terms of money, almost wholly in the "pound sterling." Contracts made in that monetary term, "pound sterling," can be liquidated or satisfied only by the weight of 113.0016 grains of pure gold to each pound.

The price of all the great crops of this country, of which, on the average, fifteen per cent. have been exported year by year for the last ten years, is fixed by their valuation for export on the gold basis. By that fact the domestic commerce of this country is bound to the single gold standard or unit of value, whether we will or no.

We have sold to the machine-using, gold standard nations—Great Britain and her colonies, France, Germany, Holland, and Belgium—our excess of food, fibres, and fabrics to the extent of eighty-three per cent. of all our exports. The gold value of our exports (mainly consisting of the products of agriculture) in the last decade, in excess of our imports from these specific countries, has been, in round figures, $2,500,000,000. The advocates of the free coinage of silver dollars of full legal tender propose to enable the bankers of Europe to gather in the silver bullion of the world, of which the market value is now 68 cents per ounce, to send it to our mints to be coined without charge, and then to force it upon our farmers, wage-earners, and other persons at $1.29 1/2 an ounce, thus cheating them out of about half their dues for the benefit of two privileged classes,—the silver miners of the west and the foreign bankers and their agents of the east.

Such being the facts, the source of the present discredit and depression may surely be found in the Bland and Sherman acts, under which the demand debt of the United States was increased, by an issue of notes or promises to pay, by nearly five hundred million dollars for the purchase of silver bullion which, when coined into dollars at sixteen to one, is bad money. We may easily trace the cause of our present bad conditions to the enforced use of bad money. Bad money is any coin of full legal tender which is not worth as much after it is melted as it purported to be under the act of legal tender or on its face. Bad money drives good money out of circulation.

A minor cause of the present discredit and distrust which pervades the community is to be found in the act of 1890 for the reduction of the revenue, the so-called Bland and Sherman acts being the prime cause. The deficiency of national revenue as compared to expenditures during the last three years has added gravely to the distrust of the community, and to the fear on the part of foreign investors of the ability of the country to maintain the integrity of its gold unit of value and to redeem bad money in good money according to the laws of the land. The very act of 1890 which caused this discredit and the deficiency of revenue made it at the same time the duty of the executive officers of the nation to maintain the parity of all instruments of exchange at the present standard or unit of value of the nation,—namely, a dollar made of gold,—without supplying adequate means. Under the acts of 1890 affecting revenue and expenditure, the revenue taxes upon sugar, which had for a long term of years yielded ninety-two cents per head, were removed. A bounty on sugar was granted. Other acts were passed very greatly increasing the expenditures of the country, while very largely diminishing the revenue. Except for this legislation of 1890, the revenue from sugar only would have yielded, from 1891 to 1895 inclusive. a sum of one hundred and fifty to two hundred million dollars in excess of the deficiency of revenue which has since ensued.

On the other hand, except for the increased expenditures of 1891 to 1895 inclusive under the acts of 1890, as compared to the rate of expenditure of the previous five years, there would have been no deficiency, even with the sugar tax removed. In other words, the acts of congress of 1890 have led to a deficiency in the subsequent five years, when, had it not been for that legislation, the national debt would have been diminished in a sum of over four hundred million dollars in the period from 1891 to 1895. (See subsequent statement.)

The penalty of this mis-legislation has been met in the panic of 1893, and the long subsequent struggle to restore the credit of the nation and the confidence of the business community. In support of these statements the subsequent tables are submitted, derived from the official accounts of the nation brought down to the end of the last fiscal year.

TABLE 1.

Analysis of the Receipts and Expenditures of the United States for sixteen years, including fiscal years ending June 30, 1879 (gold payment resumed Jan. 1, 1879), to June 30, 1895, inclusive.

Revenue, sixteen years, 1879 to 1895 inc.

		Per head.
Taxes collected upon liquors and tobacco, domestic and foreign	$2,503,422,382.	2.50
Taxes collected upon sugar	649,019,968.	.65
Miscellaneous receipts, public lands, &c.	405,450,188.	.40
All other taxes, mostly duties on imports	2,503,483,875.	2.50
Total	$6,061,376,413.	$6.05

Expenditures, sixteen years.

Normal cost of government—judicial, legislative, army, navy, rivers and harbors, public buildings, and all else except interest and pensions.	$2,594,583,640.	2.60
Interest and pensions	2,382,003,200.	2.38
Applied to reduction of debt	1,084,789,573.	1.07
	$6,061,376,413.	$6.05

TABLE 2.

Revenue and expenditures, 11 years (1879 to 1890), and 5 years (1891 to 1895), contrasted.

Revenue.	1879 to 1890	Per head	1891 to 1895	Per head.
Liquors and tobacco	1,648,979,569	2.47	854,442,813	2.55
Sugar,	599,928,621	.90	49,091,347	.15
Misc. receipts	296,632,708	.44	108,817,480	.33
Misc. duties,	1,772,353,562	2.66	731,130,313	2.19
	$4,317,894,460	$6.47	$1,743,481,953	$5.22
Expenditures.				
Normal cost of gov't	1,635,127,249	2.44	959,656,391	2.87
Int. and pensions	1,534,065,044	2.30	847,938,156	2.53
	3,169,192,293	4.74	1,807,594,547	5.40
Surplus '79 to '90	1,148,702,167	1.73		
	$4,317,894,460	$6.47		
Deficiency '91 to '95			64,012,594	.18
			$1,743,581,953	$5.22

It will be remarked that the average population in the first period was 60,000,000 ; in the second, 66,000,000. It is now over 71,000,000. Each dollar per head of revenue or expenditure, therefore, now represents over $71,000,000. The revenues are increasing in the present fiscal year, and the expenditures have been brought back to the average of the whole period from 1879 to 1895 inclusive,—namely, five dollars per head.

TABLE 3.

The variations in the total revenue and expenditures are given year by year in the subsequent table, together with the revenue from liquors, tobacco, and sugar, the expenditures also being separated :

Year.	Revenue per head.	Expenditure per head.	Revenue liquors and tobacco.	Revenue from sugar.	Cost of government.	Interest and pensions.
1879	5.56	5.46	2.31	.82	2.59	2.87
1880	6.67	5.28	2.46	.82	2.24	3.04
1881	7.03	5.06	2.63	.93	2.47	2.59
1882	7.69	4.91	2.79	.94	2.39	2.52
1883	7.42	4.95	2.80	.86	2.62	2.33
1884	6.34	4.44	2.44	.90	2.44	2.00
1885	5.78	4.63	2.25	.93	2.72	1.91
1886	5.86	4.23	2.30	.90	2.24	1.99
1887	6.32	4.56	2.37	.97	2.47	2.09
1888	6.32	4.33	2.34	.85	2.25	2.08
1889	6.24	4.60	2.43	.90	2.50	2.10
1890	6.44	4.69	2.61	.86	2.43	2.26
1891	6.13	5.55	2.66	.50	3.02	2.53
1892	5.42	5.27	2.73	.02	2.85	2.42
1893	5.77	5.73	2.74	.03	2.92	2.79
1894	4.36	5.39	2.43	.04	2.91	2.48
1895	4.49	5.11	2.36	.23	2 64	2.47
Averages	$6.05	$4.98	$2.50	.65	$2.60	$2.38

It will be remarked that the revenue from liquors and tobacco has sufficed to cover the normal cost of government within ten cents, which ten cents is substantially the *per capita* of the refund of direct taxes, the sugar bounties, and other abnormal payments which will not recur.

The falling-off in revenue from liquors and tobacco after 1883 is due to reductions of duties on tobacco ; the revenue from whiskey is substantially uniform ; that from beer has rapidly increased.

The tendency of the revenue from liquors and tobacco is to increase *per capita*, for the tendency of the normal cost of government is to diminish when judgment and economy are properly exercised ; the tendency of pensions is to diminish very rapidly, much as we may deplore the cause of such reduction.

TABLE 4.

The population which would have borne a sugar duty from 1891 to 1895 averaged 66,000,000: for five years, 330,000,000.

The net loss of revenue from the repeal of the tax on sugar was 75 cents per head..............	$247,800,000
The increase of expenditure as compared to the previous eleven years was 66 cents per head.......	217,800,000
Total loss of revenue and increase of expenditures due to the legislation of 1890................	$465,300,000
Deficit from June 30, 1891, to June 30, 1895, since increased.................................	64,012,594
Loss in debt payment in five years..............	$401,287,406

In other words, the loss of revenue on sugar, and the increased *per capita* expenditure from 1891 to 1895 inclusive, amount to four hundred million dollars, and this difference was caused by the monetary and revenue legislation of 1890.

It is admitted that a part of this change may be attributed to the legislation of the next congress after 1890, the purpose of which was defeated by the annulment of the proposed income tax. This act, however, came into force during the period of discredit and industrial paralysis which was caused mainly by the so-called Sherman act of 1890, increasing the demand debt of the country without providing any means to meet it, the silver bullion bought under that forced loan being rather worse than useless. It is becoming evident, however, that the existing laws for the collection of revenue will yield a surplus over normal appropriations, as soon as assurance is given that the gold unit of value will be maintained.

No doubt consumers have gained in the lower price of sugar what the treasury has lost,—namely, 90 cents per head,—but, when the fact becomes plain that, by restoring that duty, and by putting a duty on tea of 20 cents a pound and on coffee of 5 cents, a revenue of 60 cents per head may be secured, which additions to present revenues would suffice, not only to meet all expenditures, but to pay off the entire bonded debt of the nation in less than ten years, or in but a little over one generation since it was incurred, one may ask the question whether it may not be worth the effort. In any event, and from whatever point of view the method of collecting the public revenue may be dealt with, these plain statements of fact must be considered.

So far as the data of the present fiscal year, ending June 30, 1896, have been disclosed, the rule developed by the foregoing tables is practically sustained,—varied but little by existing depression. Bad legislation may retard, but cannot stop, the progress of this country. In spite of doubt and discredit, the power of this country to adjust its business to almost any legislation is now being demonstrated in the slow improvement of conditions, and yet more in the rapid increase in the exports of manufactured goods to the relief of the overstocked domestic market. At the time of this writing (May, 1896) there are also some indications that even the members of the present congress have begun to see the hand-writing on the wall. Genuine efforts appear to be now under way to overcome the deficiency of revenue, either by increasing the tax on beer or by some one of the very simple methods which would be apparent to any but ill-conditioned politicians who give more regard to partisan success than to the interest of the country. Witness the previous utter refusal of men in both so-called parties to deal with the revenue question on its merits, each insisting upon loading any measure offered with amendments directed to some ulterior purpose not germane to the simple undertaking to provide for the existing deficiency.

The facts disclosed in this table prove in the most conclusive manner that the expenditures of this nation, economically administered, have been amply covered in the past, and may be again in the future, at a *per capita* rate of $5, which is less than one half the taxation for national purposes of Great Britain and Germany, and less than a third that of France. It is also made plain that, under the acts as they existed for the greater portion of the sixteen years (without the last increase in the rate of tax on whiskey per gallon,—an increase of doubtful expedience), liquors and tobacco, domestic and foreign, have yielded, and would yield, a steady and substantially regular revenue to the government at the rate of $2.50 per head.

It is also made plain that a tax upon sugar of two cents a pound, equitably collected, amounted during the period in which that was substantially the rate to ninety cents per head.....	.90
It is also made plain that the miscellaneous receipts have been forty cents, and may continue to be not less than twenty-five cents, per head....................................	.25
It has also been proved by previous experience that a tax of twenty cents a pound on tea and five cents a pound on coffee formerly made no appreciable difference in the consumption of these articles. At the average rate of consumption, these two taxes would now yield per head sixty cents...........	.60
Making a total revenue from these sources of four dollars and a quarter..	$4.25

Allowing for contingencies, we have, say, four dollars with which to meet the expenditure of five dollars per head, leaving a necessity for the collection of revenue at the rate of one dollar a year, or, to cover contingencies, one dollar and a half a year, making a total assessment of $5.50 per head from a population now exceeding 71,000,000. At $5.50 per head the revenue of the next fiscal year would exceed $400,000,000,—postal revenue not included, as that is practically covered by postal receipts.

The present tariff, imperfect and unsatisfactory as it may be to either party, may be depended upon to yield a revenue under normal conditions of more than one dollar, probably one dollar and a half, per head in the next ten years, during which period this business method would yield an excess of revenue over and above all obligations, including the present pension roll. That pension roll, however, may be rapidly reduced. Hence it follows that, if the present emergency were met by a temporary tax on tea and coffee, or by a temporary increase of the tax on beer of seventy-five cents to one dollar additional, such a tax might not long be needed; after serving its purpose for three or four years, it would be repealed, unless the country should conclude to collect its revenue permanently by putting the taxes or duties on articles of universal consumption,—taxes which the government surely would receive at the least possible cost of collection.

The signs of the times indicate that the business community demands the settlement of the money question, and will insist upon the maintenance of the gold standard of value by the party succeeding at the ensuing election. Is it not also manifest that the business community, and a large portion of the manufacturing community, demand a rest from tariff legislation, until the effect of the existing laws may be worked out under normal conditions of stability, restored confidence, and relief from the effect of the late financial panic? Such a business-like adjustment to meet the present conditions may perhaps meet a general support from moderate men arrayed on either side of the tariff question.

What the business community now needs is rest from the uncertainty of tariff changes, even though it be true that the influence of prospective changes is greater upon the imagination than upon actual business.

The movement of chambers of commerce, boards of trade, and other similar bodies, and the proposed conventions of delegates from them to deal with the present causes of depression and distrust, are signs of the times by which politicians must be governed.

In conclusion, one may venture to make an approximate estimate, in terms of money, of the amount of the business transactions of this country in a single year, omitting all transactions in land, stocks, bonds, or anything of an exchangeable kind except the necessaries of life,—food, fuel, shelter, and clothing.

The business transactions, the purchases and sales of every working-day in the year at the present time, which become necessary in the process of supplying daily wants, amount, in terms of money, to not less than one hundred million dollars per day. Money of some kind is the necessary instrument of exchange. In the conduct of this enormous traffic there must be a unit or standard of value, in order that the work may be done most effectively. If the slightest doubt affects the credit of that standard or unit of value, all credit suffers; then arises what we call "depression in business." The lack of comprehension of this fundamental principle, and the lack of any apparent intention on the part of the present congress to deal with the causes of the present discredit and depression, constitute the evil to which business men are now giving their attention, and which it is their purpose to remove.

On the other hand, when the stability of the unit of value is assured, the redemption of all the obligations entered into by business men is also so well assured that the losses by bad debts incurred in the conduct of this vast exchange of products for mutual benefit come to less than a quarter of one per cent., or less than twenty-five cents on each hundred dollars of credit granted and received. The farmer who grants a credit season by season when he plants his crop months before the harvest; the mechanic who grants a credit when he makes a bargain for his month's or season's or year's work; the manufacturer who grants a credit when he buys his stock for conversion into goods for the next season's consumption; and the banker, merchant, or tradesman who grants universal credits to his customers,—are alike assured of a just return in money of the same value as that paid out or lent. When the credit of the money or unit of value is attacked, then all alike are crippled, business becomes depressed, enterprise is checked, and the evils of the panic of 1893 occur. Surely they will again occur, if the cause is not removed.

It is not difficult for any person to imagine the malignant influence of any obstruction which legislators may place in the way of this work. Let the great volume of traffic be retarded by only five per cent.; let five million dollars' worth of traffic a day be stopped by discredit,—and the goods which others need are held back, depressing the price and apparently over-stocking the market, while five per cent. of the consumers, perhaps a thousand miles away, are reduced in some measure to compulsory idleness, others to short hours, others to a reduction of wages. Five per cent. of 24,000,000 workers is 1,200,000.

Suppose the discredit to the coin of the nation assumes a graver aspect, what then occurs? The answer to that question need not be put in theory; the discredit caused by the Bland and Sherman acts, and their necessary and long-predicted consequences, were made manifest in the paralysis of industry under the panic of 1893. The congresses of the United States, by enacting these measures for collecting a forced loan of nearly $500,000,000 by the issue of legal-tender notes or cheap dollars with which to purchase the silver bullion that now lies dead and useless in the treasury of the United States, brought into force the causes of the disasters which ensued from that panic. The repeal of the Sherman act is only the beginning of the removal of the evil.

The business men of the country are now moving with accelerating force to displace the advocates of this disastrous policy from every position of trust, honor, or influence which they now hold, while farmers, mechanics, and workingmen in every branch of occupation will demand that the money in which their earnings and wages are paid shall be good money, and not bad money. The delusion of cheap money has been dispelled, and the community has learned by disaster that cheap money is cheat money.

The cleavage in both political parties is working steadily toward their disruption. Each will then be free of the burden of the silver faction, and will unite for the maintenance of good money in full cooperation with the business men of the community. The interference of the bad-money politicians will then be swept away.

THE TURNING-POINT IN RAILWAY REFORMS.

By M. E. Ingalls.

THE year 1895 was probably the turning-point in the management of railways in this country. They were only a little over half a century old,—in fact, one of the greatest has just celebrated its semi-centennial, and very few railway corporations were in existence fifty years ago,—but in this short time they have grown to immense proportions. No better illustration of this growth can be seen than in that of the corporation just alluded to,—the Pennsylvania Railroad, one of the greatest companies in the world. Statistics were not so well kept in early days as now, but in 1852 the Pennsylvania reported that it had carried 102,000,000 tons of freight one mile, at an average rate of 3.76 cents per ton per mile. For 1895 it reports 8,173,218,403 tons of freight one mile, at the rate of .56 cent per ton per mile. Nothing like it in the history and development of the human race has been known. The combination of the iron way with the propelling power of steam has advanced the world more in fifty years than all else that had been discovered in the fifty centuries preceding. It has furnished employment to an immense army of men, most of whom require a peculiar education and training for the business. A million of men (in round numbers) are engaged in this occupation; as many more in the furnishing of supplies and material necessary for the business; and over and beyond it all is the influence which this traffic has upon the life and civilization of the nation. So that a man or woman whose life and condition are not affected by railways must live in some place practically beyond the reach of civilization.

The history of the railways in this country shows the progressiveness of the Anglo-Saxon race better perhaps than anything else that history records. Greater than any conquest of a country, greater than any other advance in civilization, has been the progress of the railways in the last fifty years. Originally constructed to aid scattered communities, and, in most cases, to connect navigable waters, they have long since neglected any connection with rivers or canals, and have carried freights in quantities and at rates that even DeWitt Clinton, when he built the Erie canal, never dreamed of. Built at enormous expense, they were allowed at first to charge rates which now seem extravagant, and were given almost unlimited privileges. Fortunes were made by some of the early adventurers, but more were lost. After a little, barnacles grew up (as they always do upon every great business), outside profits were made, and various pretences were seized upon to organize parasites to fatten out of the business. There was also the contractor and promoter who built miles and miles of railway, taking the bonds, subsidies, stock, issuing as much as he could sell, selling it at almost any price, and in many cases pocketing fabulous profits, and leaving the poor owners of the railway, and the communities which it served, at loggerheads and angry with each other. The communities, looking at the large profits made by these contractors and harassed by business depression, turned upon the railways, and, by means of legislation, endeavored to regulate rates and secure reductions. The first and most notable attack was the Granger legislation, which was strengthened and made more acute by the panic of 1873. The railway officials themselves, encouraged and spoiled by the great power they had, in many cases were insolent and lawless, and this added to the trouble. The fight as to whether railways were public corporations and could be controlled by legislation lasted for many years, and finally culminated in the decisions of the supreme court that there were certain limitations which legislation could apply, and, ultimately, the enactment of the interstate commerce law, which endeavored to regulate all the railways in the country that were doing interstate commerce; and there were practically none that were not. This law was passed in 1887, and I think we may conclude that from that time the question was settled that railways were public corporations, subject to legislative control. Previous to that, rates were raised or reduced without any notice, and it was considered proper to make certain rates to one man secretly, and higher or lower rates to his neighbor. The fact is, however, that such practices were undoubtedly illegal under the common law, and the interstate commerce law really did not much more than put in statute form the unwritten common law of the land. It did, however, affix a penalty to the practice of giving rebates and secret considerations, and made such practices a crime. After its passage, it was accepted by the great body of railway managers, and for some little time—one year at least, and perhaps two or three—it was obeyed, and rates were fairly well maintained. Soon, however, companies in search of business began to resort to their old tricks of securing it, and by various subterfuges evaded the law; and, after the decisions in the Counselman and other cases, these practices became more bold, and even many of the lines which desired to obey the law were forced to meet the practices of their competitors or lose their business and see their companies go into bankruptcy.

Probably a worse state of affairs never existed in reference to a large business interest than that which prevailed among the railways in the early part of 1895, for which reason I stated in the beginning that that year marks the turning-point in railway management. In June, 1895, there was held in New York a meeting of representatives of the lines between the Mississippi river and the Atlantic ocean, and north of the Ohio and Potomac. I have never before seen a body of men, managing great enterprises, so discouraged over the situation, and so hopeless of any future. Rates on grain from the Mississippi river to the ocean were being made at ten cents per hundredweight; westbound, rates from the seaboard cities at almost any figure that the shipper cared to ask for. A large number of lines were in bankruptcy, and many more which have since gone there were trembling on the brink. Because of the most utter want of faith in the promises and assertions of many railway officials and agents, their word or agreement was accepted, if at all, among each other, with the greatest distrust and suspicion, and the public generally was not slow in learning the true situation. There was then in progress an education in this suicidal method of railway business. A few of the managers present thought it worth while to attempt a reform, and, after some effort, succeeded in inducing all to join. It was then agreed by the presidents of the large railways, in the territory I have alluded to, that tariff should be maintained on and after July 12, and a committee was appointed to devise some new plan for maintaining tariffs in the future. All through the summer and fall many of the chief railway officials worked at this business, and out of it grew what is known as the Joint Traffic Association. Just as this was starting, there came the decision of the supreme court in what is known as the "Brown" case, which practically decided that parties under prosecution for giving secret rebates can be compelled to produce books and tell what they know, if they are not on trial themselves; this aided in what we were doing, and the result has been that from January 1 tariffs have been maintained practically all over the country. Other associations in other districts followed in the lead of this strong one, and in the twenty-five years that I have been managing a railroad I have never known such an adherence to tariff as we have had for four months. The burden is upon all to see that this improvement is made permanent, and, unless it is, the profession will be disgraced, and conscientious men will want to leave it and seek some other employment. If the railway business of this country is to be conducted in the future, as it was to an alarming extent for, we will say, the two years ending June 30, 1895, those of us engaged in this profession would lose the respect of ourselves and of our fellow-citizens, and deservedly so. These, I know, are strong words and harsh ones, but they are true. If, on the other hand, the business can be conducted with strict regard to law; if tariffs can be maintained and agreements enforced,—it is a business that will demand the brightest and best minds of the country.

It is undoubtedly true that the interstate commerce law requires amendment in various ways, but I am sure that these amendments will be easy to obtain, when we have shown that we can maintain the law as it is; if, however, we are to be a law unto ourselves and pay no attention to the statute, we cannot hope for any amendments.

This business is so large that it cannot be conducted as are ordinary mercantile affairs. The merchant who sells boots and shoes or clothes knows something about the price or cost, and he does not sell below cost very long. But in the railway business we employ thousands and thousands of soliciting agents, many of whom have no idea of cost, and who think their business is to secure quantity rather than revenue. They have not, nor has the public, been educated up to the fact that giving away transportation is giving away money. A man asks for a pass from St. Louis to Chicago; the official thinks it costs nothing, and he thinks he is getting what is of value to him, but of no value to the railroad. If the official were educated to the point where he could see that he gives away fifteen dollars when he gives away a pass to Chicago and return, and if the petitioner understood that he asks for that amount of money and receives it, there would not be so many passes asked for or given. The same is true of reduced freight rates; when railway managers and shippers learn that two-thirds of the business at full tariff pays more than a hundred per cent. at half rates, rates will be maintained better. There has been a great education in this respect, and among railway owners and managers there is a large advancement. Fifteen or twenty years ago a man who had the reputation of being smart at getting business by surreptitious means was in demand. To-day he hunts a long time before he gets a position: and, when he gets one, instead of attempting to make his reputation by having it known that he is cutting rates to secure business, he endeavors to build up a reputation for conservatism. This all shows a gradual education of the community, which in the end will produce beneficial results.

The railway officials of this country must be educated to respect their tariffs, and, unless they do respect them, there is no future for railways. Tariffs should be made by the directors, and, when once made and published, they should not be changed, except by the same authority. Freight and passenger men should be taught that they are employed to secure business at tariff, and not by reducing it; that they can present the advantages of their lines as to safety, convenience, and dispatch, but that the published tariffs cannot be varied from. When this is once established, railway operations will be profitable, and railway management will be respectable.

One of the strange anomalies of the times, and one which shows how the public conscience is debauched and has lost its regard for the law, is the fact that there seems to be more trouble to-day in maintaining tariffs and obeying the law in the cases of railways in the hands of receivers than in any others. In other words, some of these railways are still reported to be securing business by secret contracts and illegal rebates. I have no question but that these practices are unknown to the court. One of these days some judge will wake up to this situation, and put an expert upon the accounts of his receiver, and then we shall get an example that will be useful. An officer of the court surely should not be a violator of the law.

The shippers from an interior city—such, for instance, as St. Louis—and those who are engaged in the management of its railways are particularly interested in the maintenance of tariffs. Under the old plan, a few large business concerns were getting enormous rebates, and were thus able to drive out all competitors; in fact, the entire profits of some large shippers consisted of the illegal rebates which they secretly obtained from the railways. This was more disastrous to an interior city than to a city like Chicago, which had the advantage of lake transportation as well as of rail. Chicago shippers could always get concessions from the railways to meet the lake rates, and thus were enabled to attract to their city a large commerce, which, if rates had been strictly and impartially maintained, would have been more equitably apportioned. The fact that their commerce was also so much larger enabled them to sell their business at a greater profit when the railways were secretly offering the lowest freight rate to the best bidder. It will take some time to adjust business to the new state of affairs, but, if the present conditions can obtain for a short time, the shippers and the community generally will be as well satisfied as the railways. Each man will know what he has to pay, and will not have to use disreputable means in order to compete with his neighbor.

I have tried to sketch briefly the rise and development of railways, and their difficulties. I have so much faith in the ability of the men who are managing them that I have no doubt that in the future they will avoid the pitfalls of the past. I congratulate those who are connected with a business that has done so much for the world in the past and promises so much for the future.

It is pleasant to dream of what would have been if railways had not been. How could this great country of ours have been developed? Would its imperial cities have been built? Then turn to the other side of the picture, and wonder what it will be fifty years from now. Our country is so immense that, as it could not have been developed in the past except by railways, so will it be impossible to realize the bright visions of the future that we all have, except by their aid. Fast time has come to stay, and each year the speed of passenger trains between the great cities will be increased, until the "Knickerbocker" out of St. Louis at noon will reach New York the next noon or sooner. The railway carries in its hand great promise to our country for the future. Let each official strive to make the profession an honorable one: to conduct his business so that the community will respect and honor him: above all, let him heed the admonition, "to thine own self be true."

A most admirable feature of the new era is the formation of the railway clubs. There is nothing like union and association to improve and advance men. The social features are of great advantage, but more than all and above all is the good that comes from conference. Rough edges are rubbed off, sharp competition is forgotten, and the good which can be accomplished by union is learned and remembered.

The last twenty-five years have brought about a wonderful advance in friendly feeling in the operation of rival railways. Just a little over a quarter of a century ago, when an important bridge on a certain western road was burned, the president of the competing line hoisted the flag over his own company's terminal station in celebration of the event. To-day, should a bridge go down on either of these roads, the train-despatchers would at once arrange to move the trains of the unfortunate railway over the other line, without friction or delay and without reference to the presidents or general managers,—very possibly before the higher officials had even heard of the calamity.

Great benefit to all results from association. Each railroad official may still strive for himself and his own line first, but never in forgetfulness of his duties to others and to the general public.

FILTRATION OF MUNICIPAL WATER SUPPLIES.

By Rudolph Hering.

MORE general attention is being given to the subject of filtering water supplies now than formerly, and sanitation rather than luxury is the standpoint from which it is being considered, for the following reasons:

(1) Scientific research has demonstrated that certain diseases—such, for instance, as typhoid fever, cholera, and summer diarrhœa—are caused by, or hold some relation to, certain minute organisms or pathogenic germs, bearing the generic name of bacteria, which are found in the bodies or discharges of the afflicted persons.

(2) Carefully-kept records and close observation in both Europe and America have demonstrated the fact that communities supplied with water previously polluted by the discharges from such persons have had epidemics following such pollution.

(3) Statistics and research have further demonstrated that communities partaking of water which had thus been polluted, but had been subsequently filtered, were much less affected, and sometimes almost entirely spared.

(4) Chemical and bacteriological analyses of waters made before, during, and after filtration have demonstrated the gradual reduction, and, under certain conditions, the complete removal, of specific kinds of bacteria, as well as of much of the organic matter contained in the unfiltered water. Experiments have further shown under what conditions this removal is most readily accomplished. In other words, the action of filters is now better understood.

In this short article the mention of a few of the many facts which have led to the above conclusions must suffice. Cases are numerous where wells polluted by the infiltration of typhoid discharges from near privies have caused typhoid fever among those who drank the water. The Plymouth, Pa., epidemic of typhoid fever, where more than one thousand cases and more than one hundred deaths were caused by the discharge of typhoid excrements from a single person into the mountain brook that supplied a part of the city with water is a most remarkable instance. In Burlington, Vt., epidemic diarrhœa, which in a mild form prevailed for many years, and was unquestionably caused by the sewage-polluted water-supply, totally disappeared as soon as the source was changed.

The accompanying map, showing the territory near the boundary line between Hamburg and Altona, illustrates a striking case where

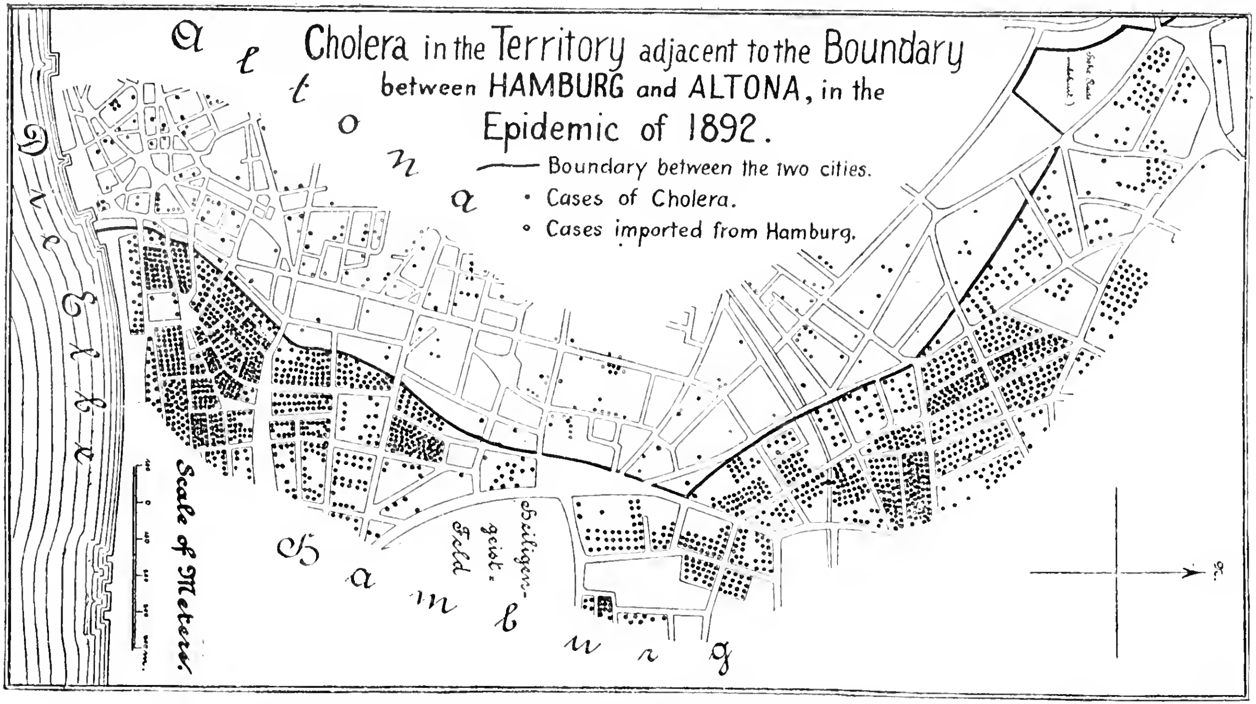


CHART SHOWING DISTRIBUTION OF CHOLERA CASES IN THE EPIDEMIC OF 1892.

the filtration of the water-supply caused immunity from cholera in the epidemic of 1892. The two cities, together having about 800,000 inhabitants, form one continuous built-up area. No person, unless informed thereof, would notice the boundary between them, which is marked on the map by a heavy line. Yet the governments are wholly distinct and independent of each other, Hamburg being a free German city, and Altona (formerly Danish) a Prussian city. Both procured their water-supplies from the sewage-polluted tidal river Elbe. Hamburg used the water as it was pumped from the river just above the city, while Altona took it below the city, but filtered it through sand filters.

The cholera epidemic started on a ship which had entered the common harbor from an infected port. The small black dots on the map indicate the resulting cases within the area shown. It is seen how few there were in Altona, and that most of these were either imported from Hamburg or were caused by using Hamburg water. The origin of the remaining cases in Altona could not be reliably traced. Filtration of the water-supply had accomplished this result. Since the Hamburg filters were put into operation in 1893, the cholera has not returned, the general death-rate has fallen, and that of typhoid fever, in particular, fell from an average of about 30 per 100,000 to 6 per 100,000.

English, German, and American investigations of recent years have demonstrated how filters act, and it is now possible by measurement and calculation to state very closely what results can be obtained by filtering water of a known degree of pollution, at a known speed and through porous material, of which the character, depth, and size of grain are also known. It has been shown that a filter, besides acting as a strainer, converts organic matter into mineral compounds, while the water is passing through the pores of the material. This conversion requires the presence of bacteria in the pores,—proven, for instance, by the fact that, when a sufficient quantity of poisonous matter which destroys them is contained in the water, or when a sufficient quantity of oxygen necessary to sustain them is not contained in it, the process ceases.

With such information the practical engineer can design his works so that they will be more efficient than formerly from a sanitary standpoint.

When filters are to do their best work, the water should have but little sediment in it. It is, therefore, desirable, and sometimes essential, first to subject it to sedimentation, so that its quality may be more uniform, and a too rapid closing up of the pores of the filter may be avoided. For this purpose settling-basins are provided, where turbid waters are to be treated. The writer has found them used extensively in Europe, but in our country their value as a preliminary to filtration does not yet seem to be generally appreciated. A filtration plant for one of our largest cities has proved a practical failure because of the omission of such basins.

Examinations by Frankland, in England, have shown that they are useful, also, in removing from eighty to ninety per cent. of the bacteria, which are carried down with the suspended matter.

James P. Kirkwood, one of the ablest of American engineers, as early as 1866 suggested their necessity as a preliminary to filtering the water-supply of St. Louis. Since the recent extensions built under the efficient direction of Mr. M. L. Holman, water commissioner, that city has the largest series of settling-basins in the country. They are designed on the "filling and drawing" plan,—that is, the water is given an opportunity for quiet settlement, instead of passing through the basins with a continuous, but very slight, flow. One day is allowed for settlement, during which time the water is materially cleared for over twelve feet in depth. While this treatment improves the water to a great degree, turbidity still prevails during the spring and summer freshet periods. It has been suggested that the Mississippi water be clarified at such times by the addition of precipitants, such as alum, but no decision has yet been reached, nor has any specific plan of filtration yet been adopted. The accompanying views show the new settling basins and the method of cleaning. (See pages 637, 642, 643.)

The methods of filtration available for further purifying the water-supplies of cities may be divided into two classes,—rapid and slow. By the former method we may filter as much as 300 cubic feet per square foot of surface per day, and obtain a thorough clarification and a removal of 98 to 99 per cent. of the bacteria, but no removal of dissolved organic matter. By the slow method we filter from 5 to 10 cubic feet per square foot of surface per day, and obtain a surer and more complete removal of both bacteria and dissolved matter.

If much dissolved organic matter remains in the water, a subsequent fermentation and a renewed bacterial growth may take place. The rapid method is, therefore, not as efficient as the slow method, but the purification obtained by it may in many cases be quite sufficient; and, if it be accomplished at a less expense, and the necessarily large waste of water required for cleaning be not objectionable, it would naturally often be preferable to the slow method.

Rapid filters depend for their sanitary effectiveness not only upon a carefully-selected sand, the grain being of definite and uniform size, but also upon a coagulation of the organic matter and the formation of a gelatinous deposit or film upon the top of the sand. To produce the coagulation, it is necessary to add to the raw water certain materials, alum being the most common. The bacteria are then carried down with the precipitate, and prevented by the gelatinous film from passing through the pores of the filter.

In some filters iron is used instead of alum, as in the Anderson process at Antwerp, and the Sellers process at Wilmington, Del.

As it necessarily takes time for the film to form (according to some authorities at least thirty minutes), as its continuity can easily be destroyed, and as it is, in fact, wholly removed every time the filter is cleaned, it will be seen that considerable skill and care are required to prevent a large proportion of bacteria from occasionally passing through the filter and appearing in the effluent water.

So-called pressure filters, where the water is forced through the filter under a considerable and varying head, are not as effective as gravity filters, where the pressure is lighter and more uniform, and therefore less likely to injure the continuity of the gelatinous film. The latter are, therefore, preferable for domestic water-supplies.

Mechanical filters may save the building of settling-tanks for prior sedimentation in cases where these would be advisable for slow filtration; such cases, however, are infrequent.

A valuable report prepared by Mr. E. B. Weston, C.E., has lately been issued, as an appendix to the annual report of the Rhode Island State board of health, which describes experiments made in Providence, R. I, with a Morison mechanical filter thirty inches in diameter. This is the first instance, the writer believes, where careful and prolonged tests of the bacterial efficiency of any rapid filter have been made. The city of Louisville, Ky., is now conducting a more extensive series of experiments with three or four rapid filters of large size, which promise further valuable results, both bacteriological and chemical.

The conclusions reached in Providence point to a preference for alum as a coagulant, added to the water in the proportion of about half a grain per gallon. The water is said to have been filtered successfully at the rate of 90,000,000 to 193,000,000 gallons per acre in twenty-four hours. The removal of from 70 to 80 per cent. of the color from the water was effected. The washing of the filter was found to be easily accomplished in about eleven minutes, with a quantity of water averaging about five per cent. of that filtered during each run. The quantity which had to run to waste after washing, until a proper film to retain the bacteria had again formed on the surface, averaged about three per cent. of the whole quantity, and the time for the film to become effective was thirty minutes. The average time for one run of the filter was sixteen hours and forty-three minutes. The average bacterial purification obtained was 98.6 per cent., the lowest was 66 per cent., and this latter result was ascribed to a preventible condition. Unfortunately, but few chemical analyses were made, and the only results that are published indicate that the reduction of the organic and volatile matter was imperceptible. It was further found that the quickest and cheapest method of washing mechanical filters was by using steam and soda ash.

The estimated cost of a plant for filtering 15,000,000 gallons daily for Providence is given by Mr. Weston at about $230,000. The cost of filtering 1,000,000 gallons is estimated by him at $7.86, including interest on the cost of plant, deterioration, etc.

By slow filtration a still more complete removal of bacteria may be accomplished, and in addition, the dissolved organic matter is reduced. In this process the effective sand grains and interstices are much smaller, and consequently allow of slower percolation. Like the rapid method, it removes the suspended matter, but, in addition thereto, it reduces, solely by natural processes, the color and the dissolved organic matter. It also gives greater assurance of the complete removal of pathogenic bacteria, on account of less frequent disturbance of the surface during the washing of the filter. Slow filters must, of course, also be cleaned, but at much less frequent intervals

While simple subsidence under favorable conditions may remove from 80 to 90 per cent. of bacteria, and rapid filtration from 90 to 99 per cent., slow filtration can be depended upon to remove from 98 to 100 per cent., and generally more than 99 per cent.

To get the best results it is necessary to have a constant water pressure upon the filter, because uniformity in the rate of percolation is an essential requirement. The permissible and most effective velocity for the water passing through the filter varies, of course, and must be adjusted from time to time. Special mechanical contrivances are employed to attain this result.

The belief that artificial aeration would greatly aid the purification of water has begun to vanish. Its effect is stated by Professor Drown, President of the Lehigh University, after careful experiments, as follows: "The oxidation of organic matter in water is not hastened by vigorous agitation with air or by air under pressure. The aeration of water may serve a useful purpose, by preventing stagnation, by preventing the excessive growth of algæ, by removing from water disagreeable gases, and by the oxidation of iron in solution."

Two methods of slow filtration are now advocated,—the continuous and the intermittent. The former is the more common. It implies a constant application of the water until the efficiency of the filter is so much reduced as to require the cleaning or washing of the upper layers of the sand; this may be once a month or less often, depending, of course, on the turbidity of the water. The intermittent method requires a cessation of the filtration at intervals of one or two days, so that air can penetrate the pores of the sand and assist in the destruction of the organic matter.

In continuous filtration, as the air is at once permanently driven out of the sand, the purification depends, so far as air is concerned, entirely upon that which is dissolved in the water itself. Yet this is sufficient in many cases for all the oxidation that can take place while the water is passing through the filter. In intermittent filtration the water drains out completely after every application, thus allowing air to be drawn into the pores and to come in better contact with the water of the subsequent application.

Generally the water passes more rapidly through an intermittent filter than through a continuous one. Therefore its straining action is less perfect, and, because of the more frequent disturbance of the sand grains at every fresh application, the water is less clear. But the oxidizing efficiency of an intermittent filter is greater, and the effluent water therefore contains slightly less organic matter. So far as we know at present, there is practically no difference in the efficiency of the two processes in removing bacteria.

The preference will have to be decided according to the circumstances in each particular case. Where the water is but slightly polluted and contains a high percentage of oxygen in solution, continuous filtration is generally preferable. Where the water is greatly polluted, intermittent filtration may be the only means of making it safe for a water-supply. In a bad case it may be necessary to resort to a double treatment.

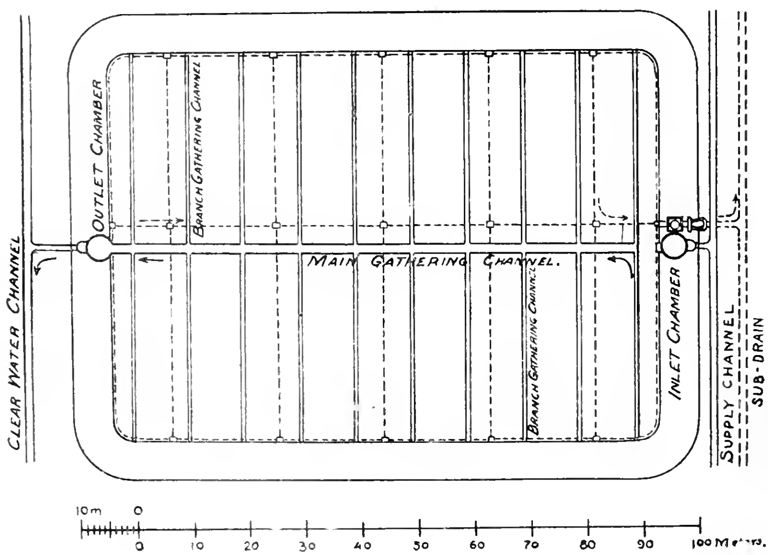
The cost of filtering water by the slow method depends very greatly on the local conditions and on the character of the water. To give a general idea of the cost, however, it may be said that filter basins, when open, can be built in the United States for an amount ranging from $30,000 to $60,000 per acre, and, when covered, from $50,000 to $90,000 per acre. One acre may be roughly considered as necessary to filter 2,000,000 gallons per day. The cost of operation, including interest on the cost of the plant, depreciation, etc., may vary from $6 to $15 per 1,000,000 gallons.

From the many works which the writer has had occasion to visit, the following two have been selected for a brief description, as they are both typical and interesting. The Hamburg works in Germany are among the largest operated on the continuous system, and the Lawrence works, in Massachusetts, were the first constructed on the intermittent system.

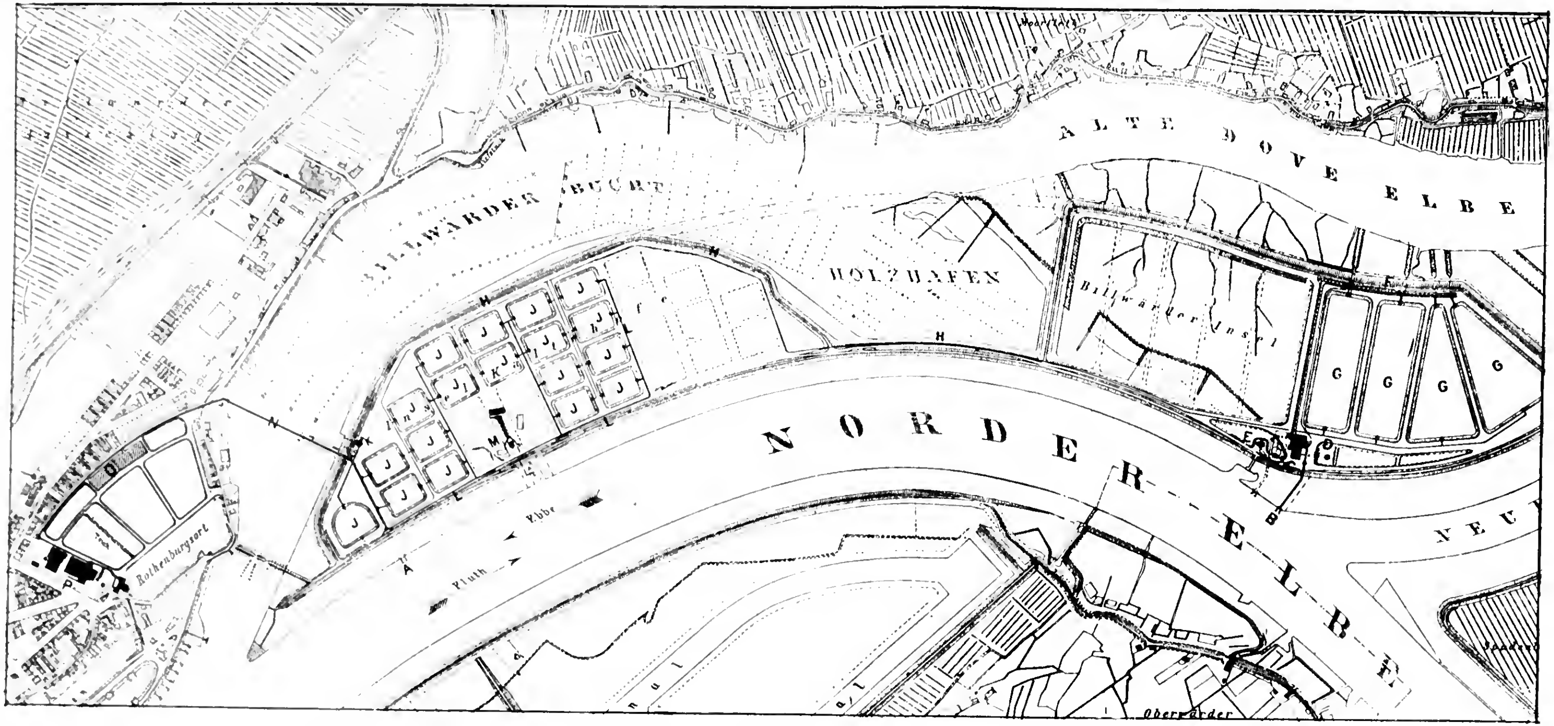
The Hamburg plant, designed by the present able chief engineer of the city, F. Andreas Meyer, was under construction at the time of the cholera epidemic in that city, in 1892, but was not put into operation until about six months after the epidemic had ceased.

The water is drawn from the river Elbe, several miles above the center of the city, and lifted with a Worthington pump into four settling-basins, each of which holds about 5,250,000 gallons. The water stands in these basins about 6½ feet deep. The time allowed for settling varies from 15 to 30 hours. The deposited sludge is flushed out into the river through a cast-iron drain 3 feet in diameter.

From the settling-basins the water flows by gravity through an 8½-foot conduit, about 1½ miles long, to the filter basins, eighteen in number. These have an effective area of nearly two acres each, and are rectangular in shape, excepting one. It is intended at present to filter 1,600,000 gallons per acre, or a depth of 4.9 feet per day. Eventually, it is thought, this rate may be doubled. The filters are open,—contrary to the general practice in Europe, which is to have them covered with masonry arches. They were made open on account of the difficulties in securing a good foundation for walls and pillars. It was thought unnecessary to incur this expense, so long as the clear or filtered water was always kept in covered channels and basins. No trouble was expected from the effect of ice, as the winter

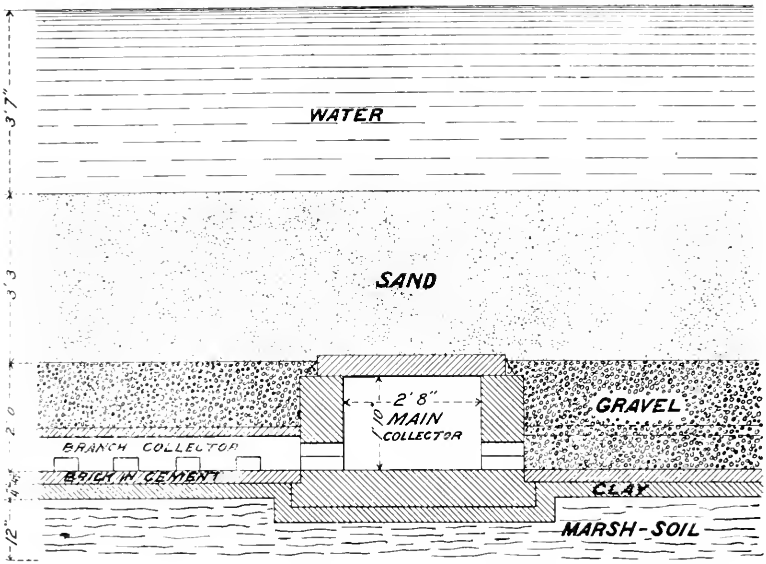


PLAN OF FILTER-BASIN IN HAMBURG.



THE HAMBURG WATER WORKS, SHOWING SETTLING-BASINS, FILTER-BASINS, AND PUMPING-STATIONS.

A. Former Intake.
B. Present Intake.
C. Pumps for Settling-basins.
D. Lighting Plant.
E. Superintendent's House.
F. Open Inlet-channel to Settling-basins.
G. Four Settling-basins.
H. Underground Supply-channel to Filter-basins.
J. Eighteen Filter-basins.
K. Pumps to Drain Filters for Cleaning.
L. Underground Clear-water Channel.
M. Laboratory for Water analysis.
N. Supply-pipe to Pumping-station.
O. Clear-water Basin, arched over.
P. Main Pumping-Station.



SECTION THROUGH HAMBURG FILTER, SHOWING COLLECTORS.

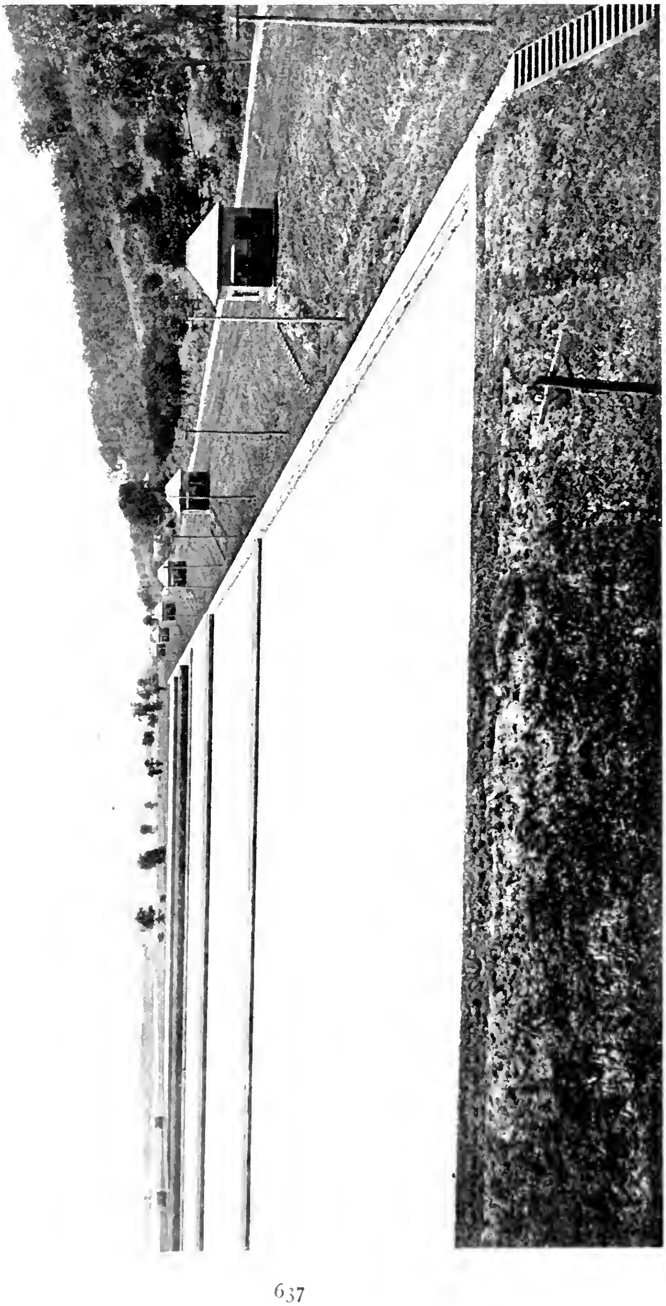
temperature is not low, and the water at such times is clearer, and the filter can, therefore, act more rapidly.

The side slopes and bottom are lined with 20 inches of well-rammed clay. Upon this are 4 inches of puddle, and finally a pavement of brick laid in cement. The main and branch collectors for the water are built as shown in the accompanying sectional drawings. The water enters these collectors through special joints in the brickwork.

Valve chambers are located on the banks, and contain self-acting valves to regulate the flow, so that a constant height of water is maintained in the filter basin.

The filtering material consists of about two feet of gravel and 40 inches of sand above it. About 16 inches of the latter is periodically removed for cleaning, and replaced. The depth of water maintained in the filters is about 4 feet. The material, before being placed, was very thoroughly washed, and then graded into various sizes, so that the coarser grains are at the bottom and the finer at the top.

To periodically clean the sand from an area of 34 acres, represented by the 18 filter basins, and varying in quantity from 90 to 235 cubic yards, depending on the season and degree of turbidity of the water, four washing plants were located, so that one could serve several basins.



GENERAL VIEW OF THE ST. LOUIS SETTLING BASINS.

Each plant has four machines, and each machine consists substantially of seven iron hoppers as shown by the drawing. A stream of clean water, with a pressure of about 16 pounds per square inch, is injected at the bottom of each hopper, stirring up the dirty sand and forcing it through a tube into the next hopper, where the same operation is repeated, until, after it settles in the seventh or last hopper, the sand is thoroughly clean. It is then loaded into trucks, and returned to the filter basin. The dirty water runs over the edge of the hopper, and then through a drain into the river. These machines are very efficient and economical. Each one requires 20 cubic yards of water per cubic yard of sand, and washes 5.2 cubic yards per hour.

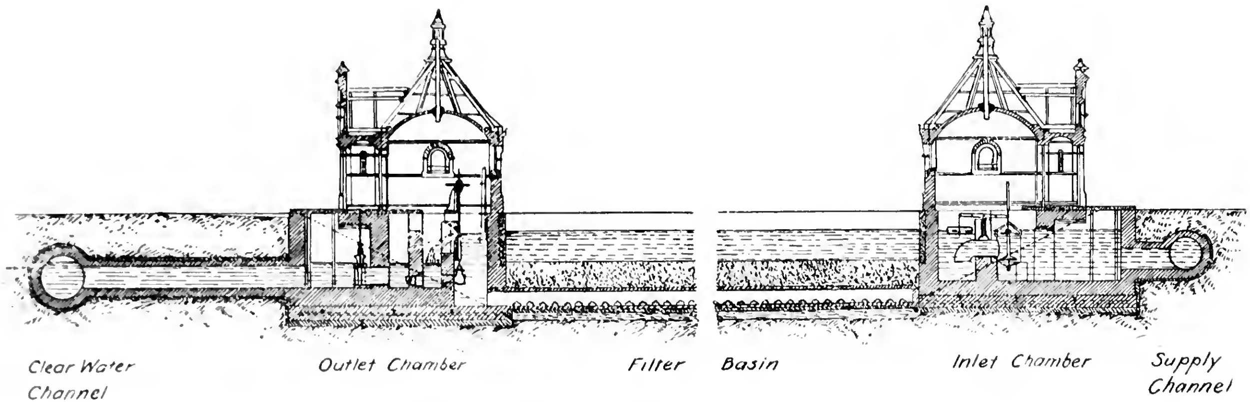
The total area appropriated for settling and filter basins is 309 acres.

The cost of the Hamburg plant including pumping machinery is $2,262,000.

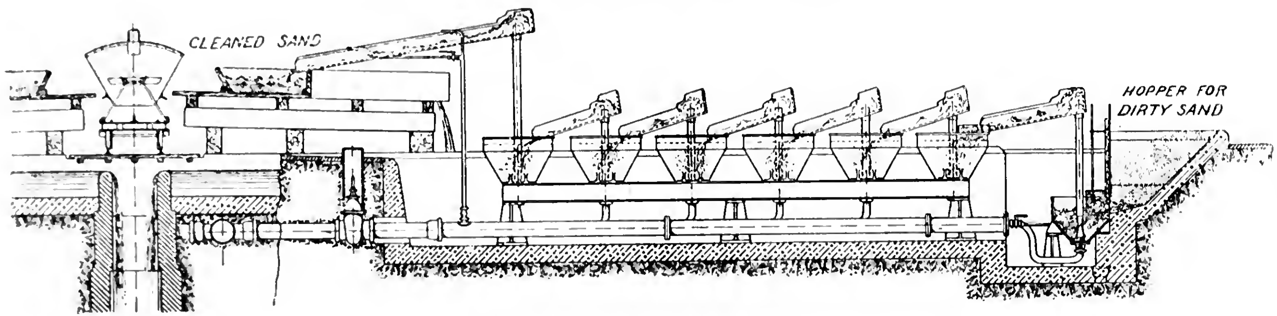
The Lawrence plant, in Massachusetts, was built under the able direction of Hiram F. Mills, C.E., member of the State board of health, and was finished in the fall of 1893. The Massachusetts board of health, in studying the typhoid fever deaths in the State, found that Lawrence had nearly three times as many per thousand persons as had other cities on an average. It was also found that they increased about one month after a similar increase had been recorded in Lowell, situated about eleven miles above on the same river. As Lawrence obtained its water-supply from this river, into which the sewage of Lowell is discharged, it was decided to build filter basins, and to purify the water according to plans suggested by the board.

The area of the basins is 2½ acres, and the proposed capacity of filtration is at the rate of 2,000,000 gallons per acre, or 6.1 cubic feet per square foot of filter area per day. The basin is situated alongside of the river, and separated from it by an embankment intended to exclude the highest spring freshets. The excavation was carried to a depth of 7 feet below low water in the river. The bottom has been left with cross ridges, as illustrated in the sections. In the depressions, which are 30 feet apart, small drain pipes with open joints have been laid, and surrounded by small stones. These are covered by layers of stones, as shown in the section, and finally by sand of selected quality. The surface of the basin has a general level of 2½ feet below low water in the river, so that it can at all times be flooded to a depth of 18 inches.

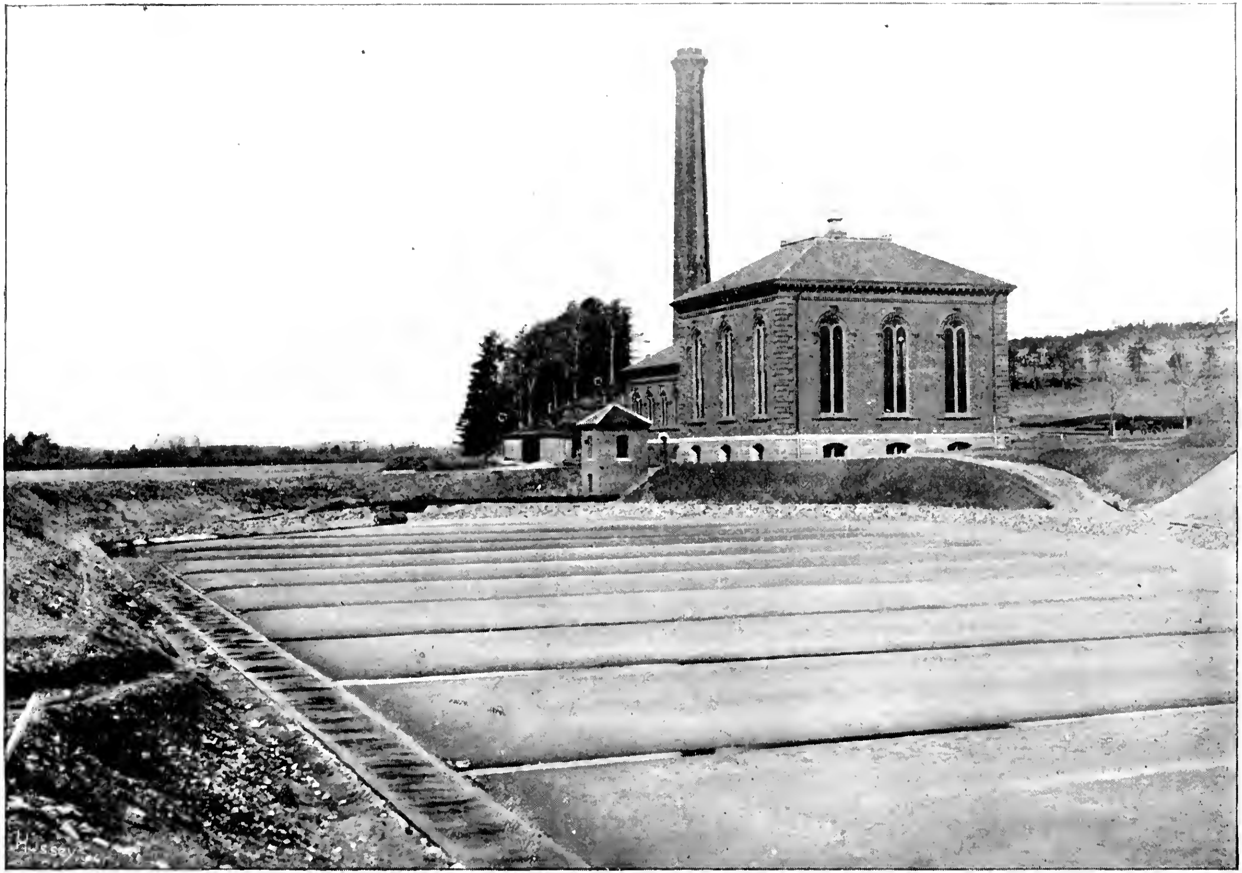
For the purpose of more evenly distributing the water over the bottom, and preventing a current sufficient to disturb the sand grains, the surface has depressions extending nearly across the basin, in which open and shallow concrete carriers are laid. See view of filter bed.



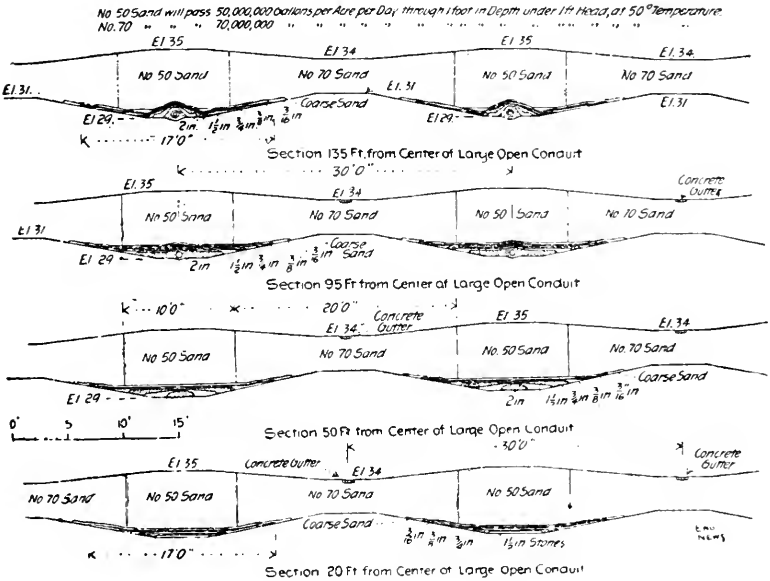
SECTION THROUGH THE HAMBURG FILTER-BASIN.



SAND WASHING APPARATUS IN HAMBURG.



THE WATER-FILTER, WITH PUMPING-STATION AND GATE-HOUSE, LAWRENCE, MASS.

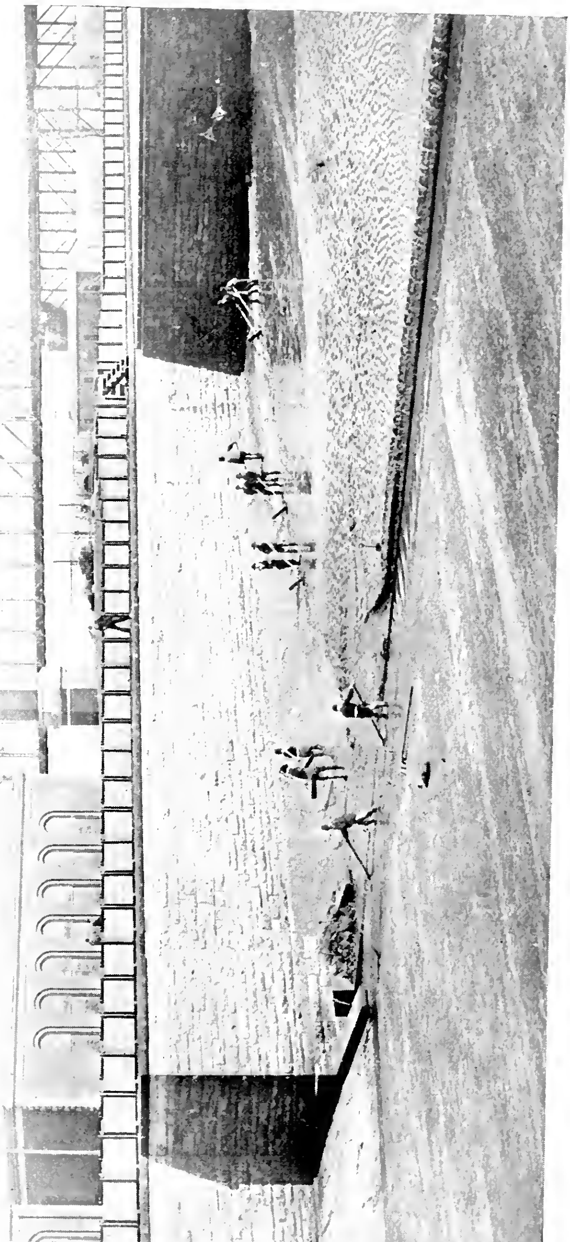


SECTION THROUGH FILTER-BEDS, LAWRENCE, MASS.

Two kinds of sand are used, which are indicated in the section by numbers 50 and 70. The latter covers the cross ridges about 3 feet deep and 20 feet wide. The former is somewhat finer, and is placed directly over the under drains, for a width of 10 feet and a depth of about 4½ feet above the layer of stones. This distribution is intended to cause a nearly uniform rate of filtration through every square foot of the area.

The cost of the Lawrence plant was $65,000. The cost of filtering is about $7.00 per million gallons, including interest, etc.

The advantages of intermittency, the period of which in this case was twenty-four hours, were to be obtained by closing the inlet gate, which supplies the filter, about five hours before the pumps stop running for the night. By that time the basins could be drained nearly to the bottom of the sand, allowing the pores in the same to be filled with air. The inlet gate was to be opened again about an hour before the pumps start in the morning, and the surface overflowed. During the winter months, while covered with ice, the filters have been operated on the continuous system.



THE ST. LOUIS SETTLING BASINS: CLEANING OUT THE SEDIMENT.

CLEANING THE SETTLING-BASINS AT ST. LOUIS.

THE UTILIZATION OF ANTHRACITE CULM.

By Edward H. Williams, Jr.

TO the average reader the term "culm" conveys little meaning, unless he has passed through the anthracite regions, where huge mounds rise beside the railroads or form a black background to the villages grouped at their feet. The term is frequently misapplied, as its original meaning, "knots" (Welsh, *cwlmau*), was applied only to those parts of the anthracite bed which were of a knotty shape; but a derived meaning applies as well to all small pieces of anthracite. In America the rock dumps which bordered the mine mouths contained little coal till in the early fifties, as the product from the mine was sent into the market without breaking or sizing, and the only coal in the dumps came from the dirt,—pieces of "bony" or "slaty" coal which were broken down in dead work, or when room in the breasts was required, or when the cleanings from tracks, ditches, and sumps were sent outside.

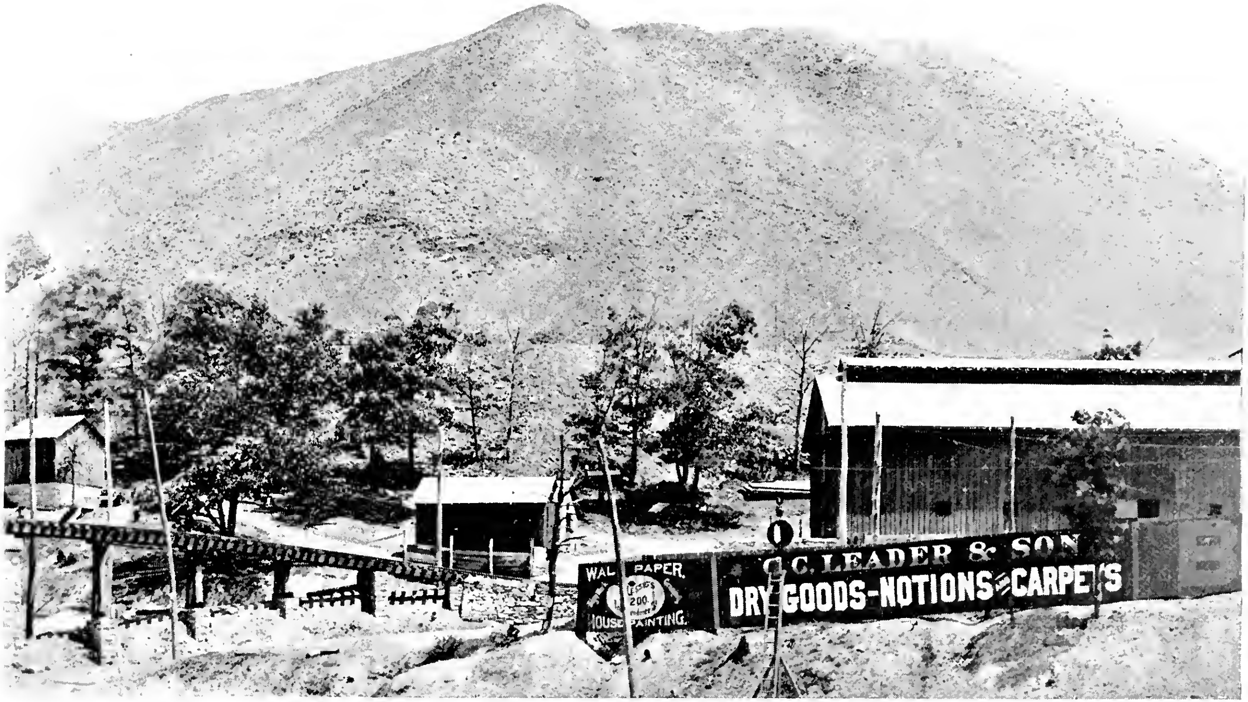
At the date mentioned coal was first broken and sized, and the air spaces in the mass were thereby increased from 37.7 to 50 per cent. of the whole, and a freer burning resulted. The grates at that period were not fitted for burning small sizes, and the smallest coal marketed was "chestnut," with diameter varying from three-quarters of an inch to one and a quarter inches. The means for cleaning the broken

THE BIG BANK AT MAHANOY CITY.

THE MOUNTAINS OF CULM AT SHAMOKIN.

masses were crude, and limited to hand-picking, so that, the smaller the size, the greater the difficulty in removing the dirt, and the smaller the demand. In many cases there were long periods when there was no sale for chestnut, or even for larger sizes, and these were thrown upon the dump, with all stuff below chestnut in size, all slate from picking, and all bony and slaty coal, so that the dumps soon received the name of "culm banks," which they still retain. The illustrations are

THE DESOLATE COAL REGIONS—CULM BANKS AT BROWNSVILLE.

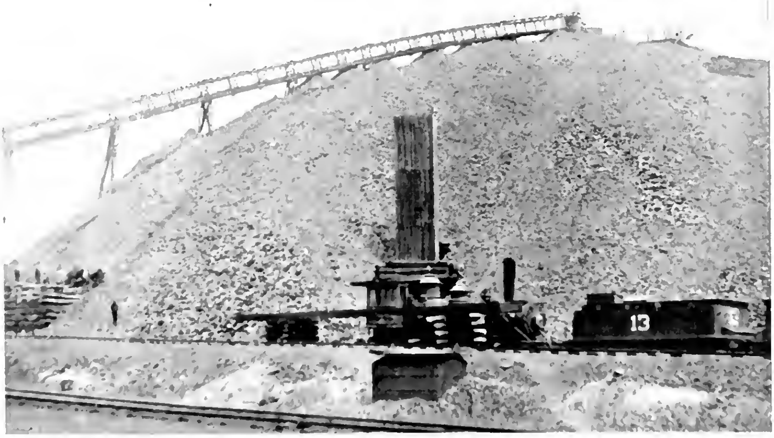


THE CULM-MOUNTAINS AGAIN: SOUTH END OF THE BANK AT SHAMOKIN.

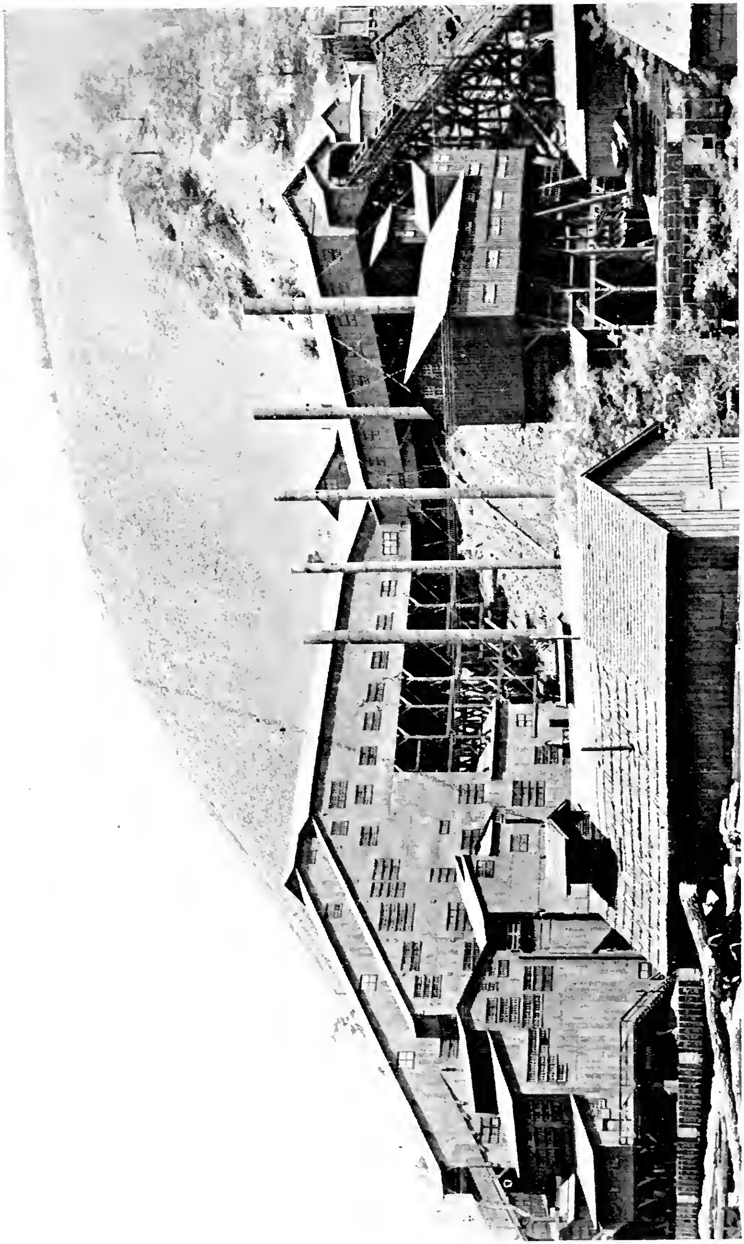
THE BROWNSVILLE CULM-BANKS, LOOKING WEST,

taken chiefly from near the extreme ends of the western middle basin, Mahanoy City and Brownsville lying at the eastern end, while the piles at Shamokin guard the banks of the creek of the same name where it makes its exit to the north-west. Drifton is in the northern part of the eastern middle basin.

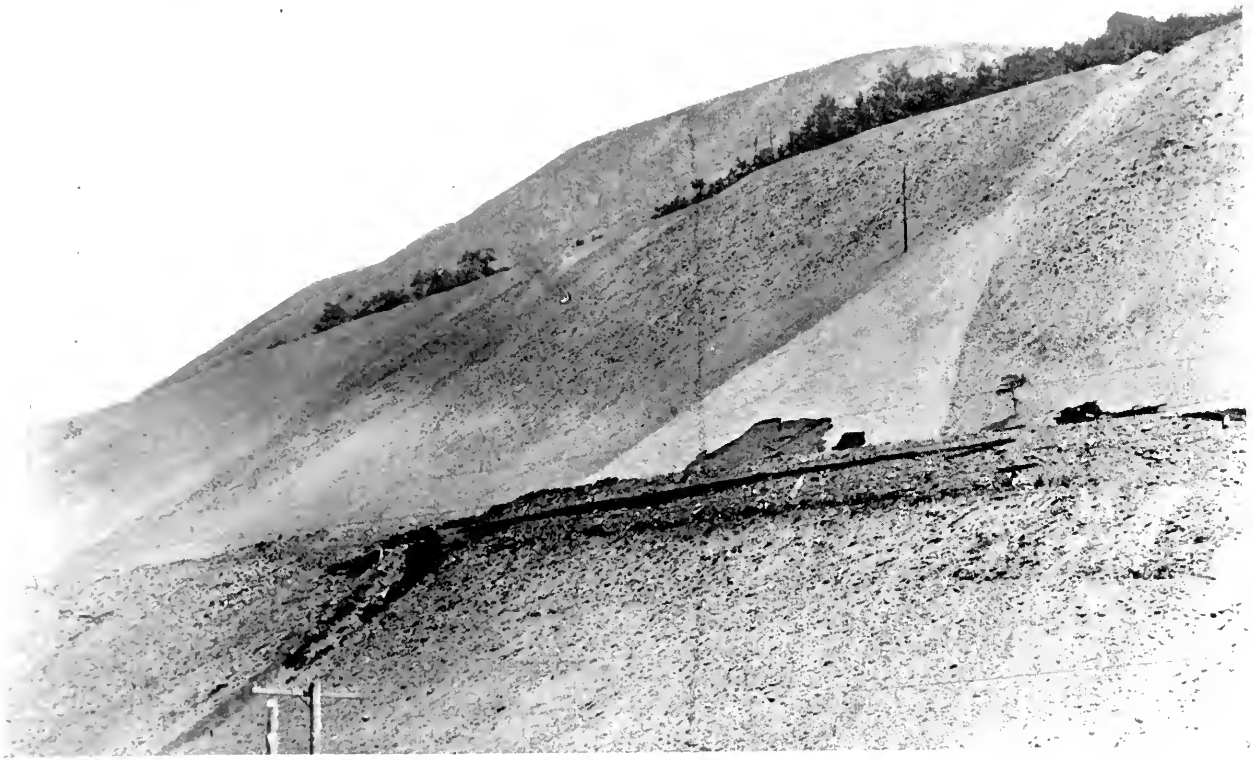
We can estimate the amount of stuff thus thrown away by taking the production during certain periods and comparing the methods of



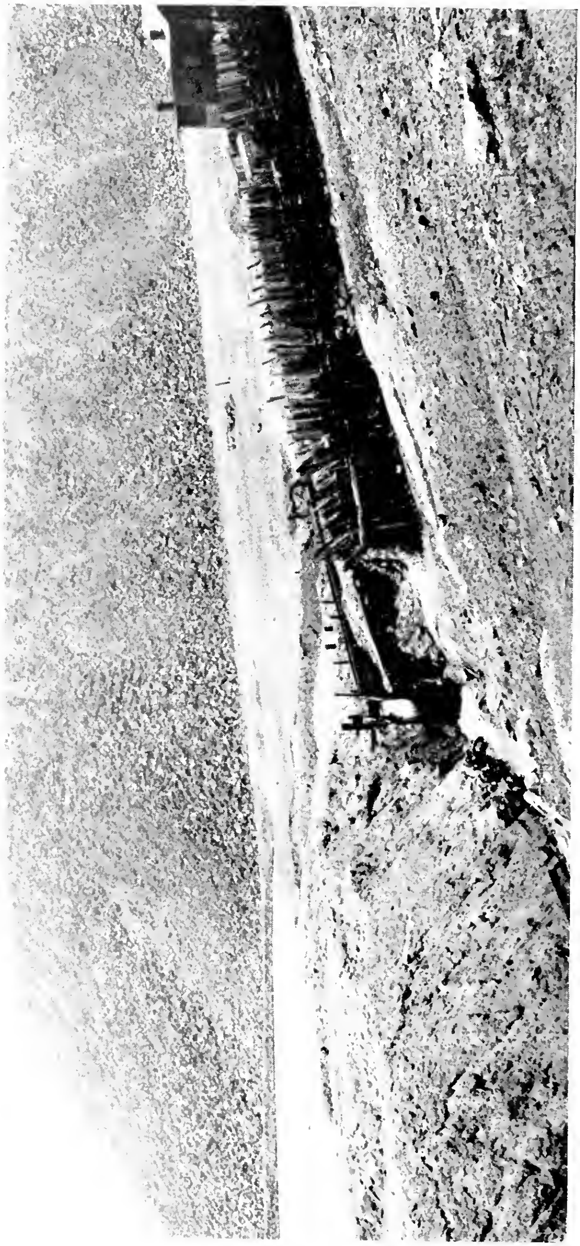
A GROWING BANK AT DRIFTON.



NORTH END OF THE GREAT BANK AT SHAMOKIN.



THE WASTEFULNESS OF THE PAST. ANOTHER VIEW OF THE SHAMOKIN BANK.



A CULM-BANK AT BROWNSVILLE.

coal preparation. For instance, from the early fifties, when coal was first broken, to the early sixties, when "pea" coal was first shipped to the general market ("pea" is from three-eighths to seven-eighths of an inch in diameter), 80,000,000 tons were sold, while, for every ton sent into the market, 1.3 tons went to the dump from the coal preparation alone, besides what was sent there from mining operations. The "culm" thus dumped is estimated at 100,000,000 tons.

From the early sixties to the early seventies "pea" coal was the smallest size shipped to market, fine-barred grates having been devised for its burning. The cleaning was still by hand, and the "pea" was usually dirty and commanded a low price. The amount lost in preparation was much diminished; so that 144,000,000 tons were marketed while the same quantity went on the dump. In the early seventies mechanical preparation of small-sized coal was introduced by the employment of jigs; these machines effectually separated coal and dirt, so that the use of small sizes greatly increased, and has been increasing up to date, when we are sending to market four sizes of "buckwheat" and one of "rice" coal, smaller than "pea" and clean in condition. The coal shipped during the thirty years since the introduction of jigs has averaged 25,000,000 tons per annum, and the "culm" sent to the dump during that period has steadily decreased; but a moderate estimate will place it at one-fourth of the shipment, or about 187,000,000 tons. The grand total for "culm" is, therefore, 431,000,000 tons, dumped since 1853. Adding to this the slate, rock, ashes, dirt from strippings, and other refuse, we have over 2,000,000,000 cubic yards, or sufficient to surround the world by a pile of triangular section and 20 feet high, or, estimating the workable coal that has been dumped, to cover the State of Rhode Island evenly with solid marketable coal 125 feet deep. Not all of this, and not even one-tenth of this, is now available, as will be shown later, and the loss has been in coal; the rock refuse remains. It can thus be seen that the land necessary for dumping purposes may be a serious expense when, as in the Wyoming valley, it is valuable for farming. It may further be seen that a large coal dump over a mine adds to the weight to be supported, and, when mixed with water so as to be "quick," may seriously menace the safety of miners, should settlings or incautious drivages, as in the case at Nanticoke, allow it to flood the workings and smother the men. The fine dirt from mining and coal preparation can not be dumped where ordinary rains will carry it into water-courses, as the covering of farm lands with culm during freshets always entails loss to the companies through lawsuits. It is to the advantage of the companies to get rid of their culm banks; but their intrinsic value was little thought of in the early days of mining, as the coal-supply was thought to be inexhaustible, and wasteful methods were employed for mining and preparation. Now that Mr. Griffiths has shown that the next generation will see the exhaustion of the greater part of the now available coal, we are turning—but too late—to our culm banks, and find but little left. The loss is due to the permission given the railroads to use the dumps as spoil-banks for grading and ballasting, or for filling deep caves whenever the underlying mines take a fancy to collapse, causing several hundred feet of track to hang across the opening like spider-webs till thousands of cubic yards of refuse fill the holes and bring back a resting-place for the suspended ties. In many cases entire dumps have been thus used.

A second method of disposal for similar reasons can be illustrated by the settling of the steeply-inclined mines under Shenandoah, Pa., where the openings were, in some cases, 70 feet high. Here the surface was pierced by numerous drill-holes, and pipes were sent down to the workings for the conveyance of culm and water to fill the workings and prevent further settling. The superincumbent water was pumped out after the solid stuff settled, and another volume of mixture was sent in till the openings were entirely filled. The mine water is highly charged with sulphate of iron, and this, being unstable and having a high affinity for oxygen, broke up into sulphuric acid and peroxid of iron (or iron rust), the acid attacking the alumina of the slates and forming alum, and iron and alum forming a solid matrix to bind together the mass, so that, after drying, the filling was found to be solid enough to sustain itself and allow drivages to be made through it without timber, as in the solid coal. This method of disposal will doubtless be employed in future with the worthless material from the jigs, and combined with underground workings, so that the coal can be removed. The method to be adopted will be: (1) the development of rooms of medium dimensions in a given panel; (2) the establishment of batteries and broken rock at their bottoms to form filters allowing the water to pass, but not the dirt, which will be run in through pipes along an upper gangway, with a pumping of the filtered water; (3) a drying of the filling in the panel, after a varying period of some length; (4) a removal of the original pillars, and filling of the spaces and the gangways, when abandoned, with culm. In this way, by sufficiently developing the lower workings of a mine, we can retreat toward the surface, and remove all the mine contents by the employment of what is now a nuisance.

Another cause of loss in the valuable portions of the banks is the habit of allowing the men who run out the waste during the winter to build fires on the surface to warm themselves. These fires, unless watched, invariably communicate to the interior. Some have been burning for many years, conclusively showing that not only coal and "culm," but even slate and rock containing small amounts of carbon, will burn, and persistently. It is a common thing to see the present waste run out over a steadily-burning and settling bank, from which abundant fumes of sulphur continually ascend, and whose white and cleanly-burned ashes show the thoroughness of the combustion. These burning banks have been a revelation to some as to methods of burning impure compounds of carbon. Further information in the same line has been derived from study of those portions of mines where underground fires have been finally extinguished. In these, as, for instance, in the celebrated case of the Butler mine, near Pittston, Pa., it has been found that the continuance of the combustion was due to the carbon in the slate and the more porous and worthless portions of the coal, while the solid parts did not burn at all, unless chipped off by the heat and accumulated in small heaps at the bases of the pillars. The slate burned freely, and even at distances from the external air,—for example, throughout the partings in the pillars, and where the only supply of oxygen seems to have been that originally contained in the interstices of the rock. How this fact has been utilized will be shown later.

Careful estimates based on actual workings show that from 40 to 70 per cent. of the culm banks is available as marketable coal. The attention of the trade is directed to them as too valuable sources of heat to be wasted, and it will now be in order to briefly state some of the many ways of utilizing their heat contents. These can be grouped under three general heads:

1. Burning culm in its ordinary state.
2. Reducing to an impalpable powder and burning.
3. Combining with some substance to form briquettes, etc.

Under the first more than fifty patents have been issued; under the second, thirty; under the third, more than a hundred. These show that the subject has excited attention.

The first attempts to burn culm were unsuccessful, because the material experimented upon was too large, and the amount of carbon exposed was slight when compared with the surface of the particles; so that, while culm banks might smoulder for years, their material would not burn in grates, as the ash formed on the outside of the pieces prevented the fire from communicating with the carbonaceous particles in the center rapidly enough to keep the temperature at the point of union of oxygen and carbon. In other words, the fire was chilled. As soon, however, as the attempt was made with small-sized culm, success was attained, as long as the fire was kept at a sufficient depth, and sufficient air was forced through the mass. The furnaces used are of three types,—with fixed, oscillating, and traveling grates. The draught is by steam jet, or by fan.

The fixed grate, consisting of adjustable bars, did not fully succeed, and it was not till Mr. Wootten brought out his perforated plate through which air was forced that burning could be said to be successful. For stationary boilers the work of charging and raking is severe, while for locomotives it requires the greater portion of the time of the fireman, and increases with the poverty of the fuel. If the draught is too strong and the fuel fine, there will be an accumulation at the flue end, which must be frequently removed. The removal of the large amount of ash is difficult with the fixed grate, and on this account the modern types are movable.

The conditions to be filled by such a grate are permanency under exceptionally hard usage; freedom from burning out, and thoroughness and ease in the removal of ash. The best types of oscillating grates rock in such a manner that the fine fuel can not fall into the pit during their rotation, and the ash formed at the bottom of the fire is systematically cut off in sections and dropped into the pit by rotating the bars in one direction, while their reversal breaks up the clinker and renders the bed porous. The advantage of this grate over the traveling type is its greater stability, and freedom from getting out of order,—the latter defect often characterizing the traveling type when old; but the disadvantage (shared by all ordinary types of furnaces) is that combustion is not so perfect as in the traveling grate, the charging of cold fuel upon the partly burned fire always chilling the lower part below the temperature necessary to combustion, causing this part to go into the ash-pit, where it is lost.

Probably the best type of traveling grate was invented by the late Eckley B. Coxe; its prominent features are the freedom of the bars from warping and their ready interchangeability. Traveling grates charge themselves; convey their burden to the place where it is to be burned; keep it there till fully consumed; and remove the ash. When the subject of draught is considered, the Coxe furnace presents another valuable feature.

As before stated, the depth of fire will be found to have a relation to the size of the fragments burned. To fully maintain a fire of large sizes, there must be too thick a bed for ordinary heating purposes. For this reason there has always been a waste in household stoves and furnaces, as the fire has been too thick for the grate area, and a large portion has gone off incompletely consumed; moreover, the thick clinkers are hard to remove, and the loss of good fuel in cleaning grates is considerable, as can be seen by examining the average ash-barrels. The experience of the writer has conclusively shown that fine grate bars and small, and even minute, sizes of coal will become the rule when people are educated to that standard; so that thin fires can be easily kept alight. With chestnut and pea coal a considerable amount of dirt will make little difference in completeness of combustion, so that, with a good furnace and a minimum draught, a single shovelful of coal every thirty-six hours will support combustion and comfortably warm a house during such chilly days as have occurred in April and May of this year. With furnaces for steam purposes, on the contrary, a forced draught must be maintained. This can be produced by fan or steam. The former produces more complete combustion, but is more destructive to the grate bars ; the latter cools the lower portion of the bed, softens the clinker, and prevents burning out of bars. The comparison between the two thus becomes an economic one, and is to be measured by dollars and cents saved during long intervals under as nearly similar conditions as can be obtained. The fan blast is more simple to arrange than that by steam, as steam and air must be fully combined before striking the fire, to prevent cold spots. The best device thus far is the "argand" jet, where steam escapes from a perforated ring of pipe, around and inside which the air enters. The ash-pit must be sealed in all forced draughts, and in the ordinary methods an equal pressure is supplied to all parts of the grate. This is not of much importance in the case of fixed and oscillating grates, if the fuel is evenly distributed ; but in the traveling grate it becomes a source of loss, as that portion of the grate leaving the furnace carries almost-consumed fuel, and air sufficient to consume the carbon in the fresh fuel is too much for portions half and wholly consumed, so that through these parts comes a blast which cools the gases of combustion in proportion to their want of carbon. The Coxe furnace avoids this by arranging the ash-pit in compartments and providing each with its amount and strength of blast, so that the highest efficiency is maintained throughout.

The second general division is that in which the fuel is first reduced to an impalpable powder and blown into the combustion chamber. The ideal furnace is one in which the fuel is kept in suspension in the air till entirely consumed, and from whose chimney no smoke issues. All of the original attempts were unsuccessful, and, according to a statement lately made before the Franklin Institute of Philadelphia, the trouble has been in the regularity of feed. In all of these furnaces there must come a preliminary pulverization of fuel, so that they start with an added cost and promise a rapid and complete combustion. Their mechanism must be somewhat complicated and delicate, and the chances of disarrangement must be correspondingly good. At present they are not numerous.

The third general division is that in which culm is combined with some substance, inert or combustible, to form a fuel which will stand handling, and should resist the weather. As early as 1837 the subject was taken up, and a patent issued. The inert substances used are clay, soap, plaster of paris, hydraulic lime, slacked lime, carbonate of soda, wood ashes, caustic soda, sulphate of ammonia, sulphate of iron, sand, silicate of potash, furnace slag, brown sandstone, geyserite jelly, black oxid of manganese, etc., either alone or combined with others; the combustible substances are legion, the principal ones being bituminous coal slack, asphalt, petroleum, dead oils from distilling the last, and some one of the hydrocarbons. The great objection to the products from any of these is that they do not sufficiently resist crushing, and so can not be stored in large quantities; or they do not resist the weather. The history of the many industries which have started in this country with flaming prospectuses and have gone out of business would fill volumes, and at present there are not half a dozen plants utilizing "culm."

The banks, however, have been attacked in another and entirely different manner,—by treating them as coal sent up from the mine and stocked. A number of "washeries" have been built of moderate height, with bars for separating the rock and allowing the culm to pass through, and go thence to the screens and jigs as in ordinary practice. The results are highly satisfactory, and, in a paper read before the American Institute of Mining Engineers in 1894 by Mr. Arthur W. Sheafer, it was shown that, in the four years between 1889 and 1894, there were shipped from the Stanton bank,

Stove coal,	19,874	tons
Chestnut coal,	31,734	"
Pea coal,	40,283	"
Buckwheat, etc.,	118,478	"
Total,	210,370	"

In this case the product averaged 60 per cent. of the total volume of culm treated. In twenty-five months 120,440 tons of similar sizes were shipped from the Draper bank, which averaged 46 per cent. of the amount treated.

It has been held by the majority of writers that culm banks deteriorate throughout. As to the slate and bony coal, this is true; but not as to the solid benches which have been worked and sent to the dump. As already shown, solid coal will not burn, and still less will its fragments oxidize, as lately shown in some of the coal strippings, where bright crushed anthracite has been sent into the market from immediately under a loose glacial cap of the first and earliest ice advance of the glacial period. The writer has found that the amount of actual rotting of this solid coal has been three-fifths of an inch during these thousands of years. From this we can see that the solid coal dumped in the culm banks is in nearly its original state at present, and the changes in its character are due to fires and infiltrations of acid waters or stainings with iron. The fact that these old banks are now in active demand, and the further fact that leases are being taken for their reworkal, show that there is good coal in them after their many years of exposure. This seems to be one of the best ways of making culm available; but, as already stated, the finer sizes of coal need not be so thoroughly cleaned for complete combustion as must the larger ones, so that a larger percentage of marketable product will probably be obtained in the future. At any rate, there are fortunes in these old dumps, and they will be used no more for filling till they have been thoroughly reworked.

While this paper was being written, there came the wonderful discovery of Dr. Jacques, by which over eighty per cent. of the energy of the carbon can be obtained directly as electricity without the intervention of machinery, by a method as simple as wonderful. Dynamos will be sent to the attics, and it will be cheaper to heat and work by electricity than by fires. In a series of iron cells Dr. Jacques places caustic soda, which he fuses at 300° F., and in the fused alkali he places rods of carbon. Air being forced through the bath, the combination of carbon and oxygen creates electricity in such quantities that arc lights can be run for hours with little or no consumption of carbon. If this is all that it is claimed to be,—and its sponsors are men who understand what they are saying,—the old culm banks contain reserve energy sufficient to furnish us with power for many generations, and the coal now in the ground will be so mined that culm banks will cease to be the most prominent objects in an old anthracite district.

THE DIRECT PRODUCTION OF ELECTRICITY FROM COAL.

By George Herbert Stockbridge.

TO obtain electricity as a direct result of the consumption of carbon has been one of the perennial problems of the electrical engineer. The history of the art discloses many attempts at its solution, and, as often happens when the answer is elusive and the rewards of success are believed to be large, not a few of the experimenters have been self-deceived. They construct their generating cell with a piece of carbon as one electrode; the galvanometer shows a deflection; what could be plainer? Yet it is most frequently the metallic electrode that is consumed, and we are left little or no wiser respecting the right way to build a carbon furnace for the production of electricity.

Still, there has been enough success in the past to encourage the late-comers, and now, if certain eminent authorities do not err, a true carbon-consuming electrical furnace, showing an efficiency of eighty-five or ninety per cent., has been invented for us by Dr. W. W. Jacques, electrician for the Bell Telephone Company, in Boston. Such an efficiency being greatly in excess of that exhibited by any previous apparatus of the sort, the significance of the new invention is at once apparent. Professor Cross, of the Massachusetts Institute of Technology, and Professor Rowland, of Johns Hopkins, declare it to be one of the great inventions of the nineteenth century, and other high authorities have expressed themselves to the same effect.

The basis of such a startling declaration is not far to seek. An electric generator depending on the consumption of coal and exhibiting an efficiency of, say, eighty-five per cent. would be nothing less than revolutionary in its effect upon the electrical and mechanical industries. To go further and develop the consideration of its effects upon the general advancement of civilization would lead us too far afield for the purposes of the present paper. One need only recall what electricity has already done for the present century to realize that the cheapening of its production might open up still other channels for its application to man's needs or to the advancement of his material and moral interests. I let the "moral" stand, for, though the setting forth of the value of invention as a moral agent is as yet an unwritten, or, at least, an inadequately written, chapter, yet no one that has lived through even a small portion of our later electrical history can fail to understand that the world is not simply more comfortable, but *better*, by virtue of the telegraph, the railway, and all the rest of the list.

However, to return to the particular case in hand, we have to reflect that the best result obtainable in producing the electric current by the employment of the steam engine operating a dynamo electric machine is not above seventeen to eighteen per cent. under the best possible conditions. The most improved triple-expansion engines have a thermo-dynamic efficiency not exceeding nineteen per cent. Granting to an efficient dynamo the capacity for converting into electrical energy about nine-tenths of the energy with which it is supplied, we get about the maximum figures above-mentioned. In actual practice ten per cent. represents a good result.

It is natural that, with so small returns coming from the indirect conversion of carbon energy into electrical energy, inventors should have looked for vastly greater results from more direct methods. Instead of heat, power, and electric current, with the inevitable losses at every transformation, why not consume the carbon, and get the current from such consumption without the intermediate steps? The theoretical advantages have long been appreciated. The practical attainment of them in a high degree seems not impossible. In any case, the significance of eighty-five or ninety per cent. efficiency for the Jacques generating cell as compared with seventeen or eighteen per cent. for the steam engine and the dynamo is plain at the outset.

In candor, it must be said that the efficiency noted for the Jacques apparatus is the efficiency of the generating cell (which will be described later), irrespective of the expenditure of heat for maintaining the cell at a suitable temperature, and of power in running the air-pump which supplies it with oxygen. In the absence of data on these points, the only thing that remains is to compare the Jacques apparatus with other direct producers of electricity from carbon, rather than with the combined steam engine and dynamo. I have already alluded to the activity in this line of invention. It now appears likely that Dr. Jacques's idea will be the subject of rival claims, and, to say truth, the earlier investigators were surprisingly near the road to complete success, however far away they may have been in the results actually obtained.

As early as 1855, Becquerel discovered that he could produce a current of electricity by burning carbon in contact with an electrolyte capable of supplying it with oxygen. His apparatus consisted of a platinum crucible containing molten nitrate of potash, into which he plunged a carbon rod glowing at its tip. The carbon was still further consumed with a resultant generation of electric current.

Better known are the experiments of Jablochkoff, who, in 1877, patented a process of generating electricity by the action upon carbon of a solid electrolyte in a state of fusion. Jablochkoff, like Becquerel, employed one or the other of the nitrates, but preferred the nitrate of soda by reason of its cheapness. For the metallic electrode Jablochkoff suggested platinum, or some other metal not acted on by the liquid in the presence of carbon. Jablochkoff's invention became the starting-point for the work of a number of inventors, who contented themselves with improving his process or the apparatus by means of which it was carried out. Even when improvements in other particulars had come in, the employment of the molten nitrates was long continued,—partly by reason of their cheapness and general availability, and partly, it is fair to assume, by reason of Jablochkoff's authority.

Later we begin to find suggestions for reviving the exhausted electrolyte by the action of atmospheric air, and even for injecting air by artificial means into the reduced liquid. As this constitutes one of the leading features of the latest improvements in the art, to which we are presently coming, it will be worth while to review for a moment what has been done along this line of progress.

One of the first to suggest the use of a current of air as a "depolarizer" was J. Hubert Davies, in 1882. Into a cell made up of molten nitrate of potash, carbon, and some metal such as iron, tin, platinum, silver, or copper, Davies passes nitric acid fumes by means of air, or he passes air alone into the molten nitrate. In place of potassium nitrate, Davies suggests as practicable substitutes monoxid or dioxid of barium, nitrate of barium, one or other of the oxids of lead, lead nitrate, cupric nitrate, and borax either melted by heat or moistened by a liquid. Concerning this cell an affidavit has been made by Mr. Charles A. Stone, pointing out that, in an actual test, the metal was consumed, and that, when heat was applied gradually, a current was produced representing less than one per cent. of the potential energy of the carbon. Substantially the same statements are made by Professor Goodwin in an affidavit.

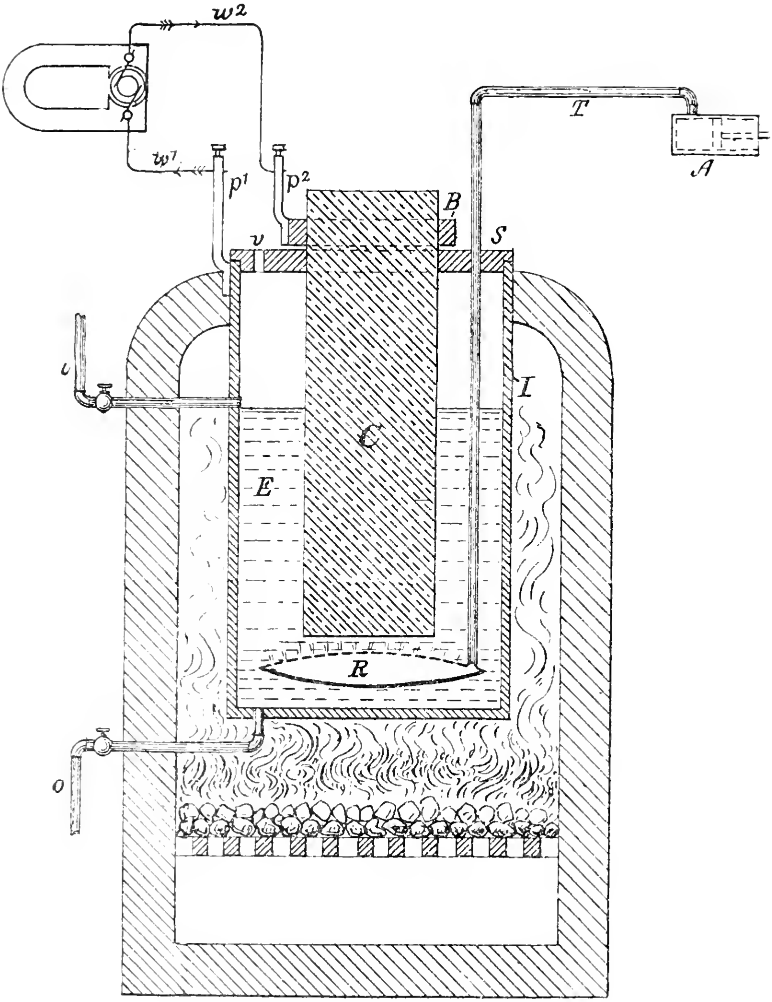
A year after Davies, Mr. Alexander Melville Clark conceived the idea of "fixing the oxygen of the air in a substance susceptible of forming a liquid combination, and then expending this oxygen to produce electricity by the oxidation of a suitable substance (generally carbon), and lastly reoxidizing by the oxygen of the air the substance which serves as the vehicle." In reducing his conception to practice, Clark makes use of potash, or soda, or both, in a state of fusion, puts the molten nitrate into a copper vessel, and plunges into the liquid a piece of carbon. Thus much is clear. But the process, as a whole, is obscure, and some of Clark's directions are either misleading or difficult to understand. According to the statements of Mr. Stone and Professor Goodwin, the current generated in a Clark cell constructed as nearly as possible by his directions is very feeble, while the copper vessel is so manifestly consumed as to coat the carbon electrode. Professor Rowland confirms these statements, and further declares that there is, in fact, no regeneration of the electrolyte as described in Clark's specification.

In 1890 Henry Gilbault proposed the substitution for Jablochkoff's nitrates of some cheaper substance reducible by the carbon, but capable of being regenerated by heat in contact with air. Gilbault conceived that it would thus be possible to prevent the reduction of the molten electrolyte by directing upon its surface or through its interior an air current. The function of the air current was to burn the carbon with an accompanying release of electrical energy. It does not appear how far Gilbault went toward perfecting his process of electrical generation.

Other inventors followed in the footsteps of Davies, whose invention Professor Rowland declares to be inoperative, because he uses nitrate of potash or some equally inadequate substitute.

This being the state of the prior art, we come now to the work of Dr. Jacques, the fortunate discoverer of a more successful and significant method of converting the potential energy of carbon into electrical energy. Dr. Jacques began his investigations some five or six years ago, and in 1891 he prosecuted a series of experiments which demonstrated the practicability of his electric furnace. By Dr. Jacques's own account, his invention is based on the discovery "that, if oxygen, whether pure or diluted, as in air, be caused to combine with carbon or carbonaceous materials, not directly, as in the case of combustion, but through an intervening electrolyte, the potential energy of the carbon may be converted directly into electrical energy, instead of into heat." Practically, Dr. Jacques supplies the active or oxidizing element of his generating cell with an excess of oxygen by means of an artificial air-blast. The electrolyte, whose first action after the cell is set up is to release its oxygen and so permit it to attack the carbon, is thus continuously renewed by fresh charges of oxygen, which are at once carried to the carbon for a continued attack. The carbon is consumed, and electrical energy is developed in a corresponding degree, the rate of consumption and the strength of the electric current being gaged by the rapidity with which air is supplied to the electrolytic compound.

The generating apparatus described by Jacques, and illustrated in the accompanying cut, consists of a pot of pure iron surrounded by a suitable furnace and containing caustic soda (sodium hydrate), into which extends a rod or cylinder of carbon. Naturally the carbon



DR. JACQUES'S GENERATING CELL.

From the Patent Drawings.

I is the iron pot, E the melted caustic soda contained in it ; C is the carbon prism, R the rose through which air is blown into the caustic soda from the air compressor, A. p^1 and p^2 are the poles between which the electric current flows.

must be in such a state that it may serve as a good electrical conductor. Gas carbon and charcoal are available without special treatment, but anthracite coal has to be baked to give it the requisite conductivity, and bituminous coal needs, for the same purpose, to have some of its hydrocarbons driven off. Commercial caustic soda can be used without expelling the usual impurities.

In addition to the foregoing elements of the generator, Jacques provides an air-pump for forcing into the sodium hydrate an excess of oxygen, the air containing the oxygen being carried to a "rose" for distributing the air currents through the electrolyte in fine sprays. The rose is made of a metal not acted upon by the hydrate. The whole being supplied with a suitable insulating cover having a proper vent, the apparatus can be set in operation by bringing the furnace and its inclosed generator and electrolyte to a temperature of 400° to 500° Centigrade, and operating the air pump. By virtue of the violent ebullition caused by the jets of air, every part of the electrolyte is brought into contact with the air, from which it takes up oxygen in excess; after which it is carried against the carbon, and releases the oxygen collected in its travels. The carbon is attacked by the oxygen, and suffers a gradual consumption as long as the operation continues.

It is found that the electrolyte needs renewing at intervals, by reason of its slow contamination by carbonate of soda, resulting from the union of some of the caustic soda with carbonic acid developed in the generating process or coming from the injected air. Moreover, the ash from the carbon tends to lessen the efficiency of the electrolyte. But, if a small percentage of oxid of magnesium be added to the electrolyte, its renewal may be sensibly postponed. According to Dr. Jacques, the oxid of magnesium serves as a carrier to convey the carbonic acid through the electrolyte. His conception of the action of the oxid of magnesium is that the free carbonic acid combines with it in preference to the caustic soda, and that the carbonate of magnesium so formed is quickly decomposed into carbonic acid, which escapes, and oxid of magnesium, which is again ready to repeat its action. In any case, that part of the carbonic acid which causes contamination is very small, the most of it bubbling up through the caustic soda and escaping into the air.

Respecting the oxidizing agent, Dr. Jacques says: "There are many electrolytes that may be used in practising my invention. Following are some of the desirable characteristics. They should become liquid at a convenient temperature. They should possess good electrolytic conductivity. They should be capable of readily taking up oxygen from the air or other source of supply, and also capable of readily giving up oxygen into combination with the carbon. They should not have a strong affinity for carbonic acid, and, in case air is used as a source of oxygen supply, should not have any considerable affinity for the nitrogen or other substances with which the oxygen of the air is diluted. The molten hydrates of potash and soda are especially suitable for practical use." The use of pure iron for the collecting electrode is recommended as generally applicable and inexpensive; but steel and iron containing a considerable amount of carbon are to be avoided. The sodium hydrate, when melted, has no sensible chemical action upon the iron, which, therefore, remains substantially unchanged.

Briefly, the process employed by Jacques consists in chemically combining oxygen with carbon by impregnating a molten basic electrolyte, which is in contact with the carbon, with oxygen or air, and collecting the electricity thereby developed by means of an electrode not acted on by the impregnated electrolyte when the circuit is completed. To render the process continuous, a sufficient heat is maintained by means of a suitable furnace, and the air-pump is kept in operation. Incidentally, the bubbling of the air through the heated electrolytic compound contributes to securing and preserving a uniformly-distributed heat, which is, of course, to be desired.

In the choice of the hydrate of sodium or potassium as an element of his generating cell, Jacques has been particularly fortunate, while, no doubt, the general adaptation of his apparatus to a clearly-defined purpose has been of great value and importance. The employment of a pure iron electrode is another fortunate detail. In a word, Dr. Jacques has disclosed an apt invention, based on a well-conceived theory of the nature of the problem alluded to at the outset of the present article. He has made clear, and possible of practice by every one skilled in the art, the notion which Clark seems to have entertained, without, however, adequately describing a working process or a working apparatus. The efficiency of eighty-five to ninety per cent. claimed for the Jacques apparatus is vouched for by distinguished electricians, who, as stated, also comment on the broad significance of the results obtained. Whether or not his experiments have achieved what can immediately be turned to commercial use it is, perhaps, too early to say: but at least he is to be congratulated on having revived the waning hopes of the scientific world respecting a hitherto disappointing search for an efficient carbon-consuming electrical furnace. Future investigations in this field are pretty sure to follow Dr. Jacques's lead.

It has been reported recently that, with a Jacques battery of 100 iron pots, 12 inches deep and 1½ inches in diameter, a current was obtained averaging 90 volts and 16 amperes and supporting thirty 16-candle power incandescent lamps for nearly 19 hours. In this test about 8 pounds of carbon were consumed in the pot. If the consumption taking place in the pot were all that is to be taken into the account, this result, representing an efficiency of about ninety-four per cent., would be of enormous interest and value. Unfortunately, we are not told how much coal it took to run the furnace and the air-pump.

In the present state of the investigation, this exclusive insistence upon the story of the generating cell seems not unfair. The great thing to prove was that an attack by oxygen upon carbon could be made effective under *any* conditions for producing current with good efficiency. If it should appear that the production can take place only in the presence of heat, or that, as one critic has asserted, the Jacques organization is nothing more than a good thermo-electric battery, the rejoicing over Dr. Jacques's work will be considerably tempered. Till that be definitely settled we may withhold our final judgment.

Dr. Jacques is a graduate of the Massachusetts Institute of Technology (1876) and of Johns Hopkins (1880). For a number of years he has been located in Boston as electrician for the American Bell Telephone Company.

RECENT IMPROVEMENTS IN GOLD MILLING.

By H. M. Chance.

THE article in the June number of THE ENGINEERING MAGAZINE sketched the extent to which the increased activity, profit, and production in gold milling was due to improved machinery and methods in use for mining, crushing, and amalgamating free-milling ores; but the progress does not stop there.

The treatment of partially free-milling and refractory ores has been bettered and cheapened by improved concentrating, extracting, and smelting methods and appliances. It is not intended to enter upon a discussion of smelting methods and appliances, as the present article proposes to deal only with those processes for the direct extraction of gold which are carried on in connection with, or as a part of, the milling plant, and which, like the chlorination and cyanid processes, are now successfully operated on a large scale.

In selecting the proper treatment for any partially free-milling ore, the first step is to determine by amalgamating tests what values per ton can be recovered by plain amalgamation when crushing to mesh of different sizes. It may happen that a very small part of the yield can be so obtained, and perhaps this may require very fine crushing with large production of slimes, which will complicate concentration and subsequent treatment. In such cases better results may be had by concentrating without amalgamation, or by concentrating, and then re-crushing and amalgamating the tailings, or, if the gold occurs in very fine particles, possibly by subjecting the ore to chlorination or cyaniding direct, or by concentrating and then cyaniding the tailings. In a majority of cases, success or failure depends upon the proper solution of this problem, the cheapening and improvements effected in treating such ores having been accomplished by working out methods rationally conforming to the peculiarities of each ore rather than by attempting to force the ore to yield to any predetermined process.

Recent improvements in concentrating appliances, in vanners, bumping tables, and slime tables, are confined to details of construction, which, while reducing their first cost and cost of maintenance and increasing their capacity, have not greatly increased their efficiency, for these machines, as built for many years, have been constructed on the same principles and have been capable of performing satisfactory work. The same statement applies equally well to jigs used for concentrating coarser material.

Until recently few mills were supplied with concentrators of sufficient capacity to properly handle the pulp, and some mills are yet equipped with ridiculously small concentrating plants. The writer has seen plants arranged to run from forty to eighty tons of pulp daily over a single vanner. Such instances, however, are becoming rare, the present tendency being to equip every plant with concentrators of ample capacity, though the fact is recognized that there is a limit at which the increased cost of concentration, wear and tear, etc., becomes equal to the value of the increased quantity of concentrates saved, and that the maximum profit will be found at some point inside this limit.

While the chlorination of refractory gold ores is not a recent invention, chlorination methods and appliances have been entirely remodeled within the last few years. First of all, and perhaps of as great importance as any other step in the process, is the improvement in roasting methods brought about by the elimination of many complicated, unsuccessful, or expensive roasting furnaces, and the survival and adoption of the simpler and better forms. The Bruckner or cylinder style roaster, and the ordinary reverberatory and revolving-pan roasters, are now thoroughly understood, and their possibilities and cost of operation have been established by long use at many plants. Some of the many forms of shelf roasters and of machine rabblers seemed destined to effect further economies, and it is probable that they will soon be more favorably received.

In the same way many chlorination methods have been tried and abandoned, and from this experimental work the simple and efficient apparatus and modes of applying the process now in use have been developed and perfected.

In working ordinary pyritic ore or pyritic concentrates present practice aims first at securing as nearly a "dead" roast as possible,—that is, to reduce the percentage of sulphur to the smallest possible quantity, which usually means to less than one per cent. and sometimes to less than one-quarter of one per cent.

The use of salt in roasting auriferous pyrites for chlorination is by no means so general as in earlier practice,—often being found unnecessary,—and, when used, it is now added in the smallest possible quantities and near the end of the roast. The loss of gold in chloridizing roasting has been reduced, but not eliminated, although, in some cases, it is claimed that, by adding the salt when the roasting is nearly complete and withdrawing the charge without attempting to make a close roast, the loss is insignificant, and the recovery by subsequent treatment satisfactory.

To Mr. A. Theis perhaps more than to any other single worker in this field is due the present admirable combination of methods, apparatus, and appliances which in the last few years have so greatly cheapened and simplified the process. His work has been marked by the development of a chemical process, formerly difficult, uncertain, cumbersome, and expensive to work, into one so simple and sure that it can be operated almost entirely with unskilled labor. The cost of treatment has thus been reduced from eight or twelve dollars per ton to from three to six dollars per ton of material treated, the lower figure applying to operations on a large scale or where cheap labor (as in the south) is available.

As this cost in most cases applies not to the whole quantity of ore, but to the concentrates only, which commonly range from three to fifteen per cent. of the ore milled, the cost of chlorination may be taken as ranging from twenty cents to one dollar per ton of ore mined. Hence it is evident that nearly all free-milling ores containing gold not recoverable by amalgamation, but which can be saved in concentrates suitable for chlorination, should be so treated, for there are few ores indeed from which the concentrates will not show value sufficient to repay with profit the cost of concentration and chlorination.

The principal item of cost in treatment by chlorination is the preliminary roasting of the ore or concentrates, which may amount to more than one-half of the total cost; excluding this, the cost of the process falls to three dollars or less per ton.

Direct chlorination—*i. e.*, chlorination of the ore without previous amalgamation or concentration—is a recent and promising extension to the process. It cannot, of course, be applied to ores containing coarse particles of gold, but there are numerous deposits to which it is adapted and on which it may now profitably be operated.

Dry crushing, by crushers and rolls, is the style of milling most popular at the present time for preparing such ores for treatment. A fair percentage of extraction has been obtained in many cases by comparatively coarse crushing, and it is claimed that the chlorine solution has considerable penetrative power, and that in a moderately short time it will dissolve the gold from coarse particles,—say from ¼- or ½-inch fragments. It is also claimed that cyanid solutions act in the same way; while this may be true of its action on some ores, it may be necessary to modify these claims, if it be found that the gold in such ores is confined to the softer portions of the ore, the larger fragments (harder portions) of the gangue being lean or barren. However this may be, a good percentage of extraction is obtained from some ores both by chlorination and by cyaniding, without crushing to fine mesh.

The most generally approved method of operating the process is by chlorination in batches, with bleaching powder and sulphuric acid, in revolving barrels, discharging the pulp on filters where it is filtered and washed by gravity or pressure, and precipitating the gold by H_2S (sulphuretted hydrogen) or $FeSO_4$ (ferrous sulphate, copperas) ; or by filtering through charcoal, the precipitate being allowed to settle, the clear water drawn off, and the precipitate dried in a filter-press or evaporating pan. This is substantially the process so successfully elaborated by Mr. Theis for working pyritic concentrates at the Haile Mine, S. C., and Mr. J. E. Rothwell for working refractory ores in bulk at the Golden Reward Chlorination Works at Deadwood, S. Dak.

At present chlorination is successfully used in treating a larger variety of gold ores than are treated by any other process. The manufacture and sale of condensed chlorine, at reasonably low price, promise to further cheapen the process, especially at many more or less inaccessible localities, where the cost of transportation of the sulphuric acid and bleaching powder used forms a considerable part of the total cost of treatment.

Bromination appears chemically similar to chlorination, but its possibilities, peculiarities, and limitations are not yet fully known. Much that is claimed for it just now may not be realized in practice, but the testimony of those who have experimented with it is, in the main, favorable, and there is reason to believe that it may prove a valuable adjunct to chlorination, and may possibly succeed on some ores not suited to that process. The present cost of bromine is the greatest obstacle to an extensive application of the process ; but this difficulty will disappear, if it be found that very dilute solutions can be used, or if some cheap and simple method of recovery be devised.

The cyanid process, known also as the McArthur-Forrest process, which consists in dissolving the gold from ore, concentrates, or tailings by leaching (or agitation) with a dilute solution of cyanid of potassium and precipitating the gold with metallic zinc, has now been in successful use since 1890. It was at first received with the skepticism usually accorded a new process, but its phenomenal success in treating tailings in South Africa soon demonstrated its value. In 1891 it was first successfully applied to treating ore in bulk, at the Mercur Mine, in Utah, and the cost of treatment was shown to be so low ($2.40 per ton) that its future seemed assured. Its use has not, however, extended in this country as rapidly as in Africa, owing doubtless to some failures here from attempting to work ores to which it is not suited. Like all other processes, this process has its limitations : (1) it does not work successfully on raw ores in which the gold exists chemically combined with some other element or elements, as in the Cripple Creek district ; (2) when the gold is intimately associated with copper, antimony, and arsenic minerals; (3) when the ore contains acid salts resulting from the decomposition of pyritic minerals, the consumption of cyanid often being so large as to be prohibitory.

The cost of treatment necessarily varies with the consumption of cyanid, which may be large or small, depending upon the presence of minerals which destroy or combine with it, ranging from less than one pound of cyanid per ton of material treated to several pounds per ton. When such minerals are present in quantity, it has been found possible in some cases to reduce the loss of cyanid by working with extremely dilute solutions (1/10 to 1/4 of one per cent.), cyanid being added at intervals to replace that destroyed or absorbed, thus maintaining the normal strength of solution.

The labor cost of the process varies with the design, capacity, arrangement, and mode of operating the plant. At some of the more recently designed plants it should not exceed twenty-five cents per ton.

After the solution has filtered through the ore, it is passed slowly through boxes or troughs filled with zinc shavings, which precipitate the gold, the solution then passing to storage-vats, where it is reinforced with sufficient cyanid to bring it up to normal strength.

The Siemens and Halske electrolytic method of deposition is better adapted to some ores than precipitation by zinc. It is effected by passing the gold-bearing cyanid solution slowly through vats or troughs filled with alternating anode (iron) and cathode (lead) plates, which are allowed to remain undisturbed for several weeks or months, when the cathodes, heavily plated with gold, are removed, melted, and cupelled. About 8,000 square feet of cathode surface is required to electrolyze 100 tons of solution in 24 hours. The consumption of current is small, 4 or 5 electric h. p. sufficing to run a large plant.

The cost of operating the cyanid process in Africa has steadily fallen, and it is claimed that tailings have actually been worked by it at a cost of 56 cents per ton. Whether such low cost be possible at other works may be doubted, but it is now well established that, under widely-varying conditions, work has steadily been carried on at costs ranging from $1.80 or $1.90 per ton down to $1.00 or less, and improvements under way will still further reduce these figures.

The example set by the Mercur Mine is being followed at one mine at least in South Africa, where the direct treatment of the ore in bulk has been accomplished at a reported gross cost of $2.50 per ton for milling and cyaniding. The growth of the process in this country, as applied to the direct treatment of ore in bulk, dates from its adoption at the Mercur Mine in the fall of 1891, with a capacity of 50 tons daily, which was enlarged to 200 tons, and is now being inceased to 400 tons. In 1892 and 1894 two plants were started in-

Montana and Utah; in 1895 six plants were installed in Colorado, Utah, and Oregon, with aggregate capacity of 380 tons daily; and one of these is now being enlarged by 150 tons, while two other plants in Colorado and Utah are being constructed.

As applied to the treatment of tailings in this country, the record compiled by the Gold and Silver Extraction Co., Limited, shows that four works, with a capacity of 146 tons, were installed in 1893, three works, to treat 116 tons daily, in 1894, and six plants, with an aggregate daily capacity of 410 tons, in 1895.

"Pyritic smelting" is another process which may properly be discussed as an adjunct to gold milling proper. It is applied to smelting heavy sulphid ores or concentrates only, and is carried no further than necessary to produce a rich matte, in which the gold contents of two, three, four, or more tons of material are concentrated into one ton of matte, which is shipped or sold to smelting or refining works for further treatment. In this process the heat developed by the combustion of the sulphur contained in the ore is relied upon to effect the smelting, fuel being used only to light the charge, after which the ore may be said to smelt itself. The process is of recent development, but enough has been done to prove its value for treating heavy pyritic ores at points distant from smelting centers.

Gold ores not adapted to free milling, chlorination, bromination, cyaniding, or pyritic smelting are at present reduced by smelting. A number of wet processes for treating certain classes of ore now going to smelters are being exploited, and doubtless some of them will prove valuable. Never before in the history of gold-mining have so many able, cultivated, and well-trained brains been working upon this problem; never before, therefore, has there been the same reason to anticipate the invention of new or improved processes.

All of the approved methods in use, when applied to ores to which they are suited, yield a satisfactory percentage of extraction. On strictly free milling propositions, it is not unusual to recover from eighty to ninety per cent. of the total free-milling contents; and, with the appliances in use, the extraction might often be run up to ninety-five per cent.; but this result would be attained at so largely increased cost as to be undesirable. The appliances used in concentration are capable of recovering a high percentage of the sulphids; and the chlorination and cyanid processes yield very high percentages of extraction. Arguing from these facts, it is often claimed that there is no room for further improvement. Precisely the same reasoning might have been advanced twenty or thirty years ago; the Mexican to day is entitled to and does make the same claims for the processes used on silver ores one hundred years ago. That existing processes and appliances are efficient, and that the possible increase in efficiency is limited, must be conceded: but it is true, nevertheless, that the field for improvement is as wide as ever, provided the aim be to find cheaper (and possibly simpler) processes and appliances, to increase capacity, and to attain efficient working at lower cost.

The possibility of enlarged profits from increased efficiency alone is limited, for a perfect process could increase the yield only from fifteen to twenty-five per cent. over that attained by the processes in use; but the possibility of enlarged profits from the combined effect of reduced working cost and increased efficiency is not arbitrarily limited to any percentage.

Improvements might be noted in rolls, mills of the Huntingdon type, ball mills, bumping tables, jigs, hydraulic classifiers, amalgamating and clean-up pans, canvas planes, and many other useful appliances, and in many of the new (and old) special processes; but so extended a discussion of the subject is beyond the limits of this article.

Mining is popularly considered more hazardous than other productive industries, because it is admittedly impossible to look into the earth and determine, in advance of actual developments, how far the character, thickness, and quality of any mineral deposit extend beyond or beneath the face in sight. But other productive industries involve like uncertainties; it is equally impossible to look into the future and determine whether the price, demand, cost, and salableness of any product will increase, diminish, or fail. This uncertainty often may be greater than the risks involved in mining, for it is always possible to so explore and develop any mineral deposit, in advance of actual working, as to expose to sight, or to prove the presence of, sufficient ore, before making a large investment. This is now invariably done by those who engage in mining in a conservative way.

An appreciation of these possibilities is rapidly raising gold mining from the level of speculation to that of legitimate industry, and with this change has come that careful attention to small economies and to minor improvements in methods and appliances which marks all sound industrial operations. From being one of the most hazardous industries, mining thus at once become one of the safest possible pursuits.

As indicating this change in sentiment, it may be noted that established dividend-paying gold stocks four or five years ago might be bought at prices netting the investor from twenty-five to thirty per cent., but at the present time these same stocks command prices at which the investor realizes only ten or fifteen per cent.; which indicates that in the opinion of those investing in these securities, the business is no more hazardous than any industrial pursuit.

MODERN MACHINE-SHOP ECONOMICS.

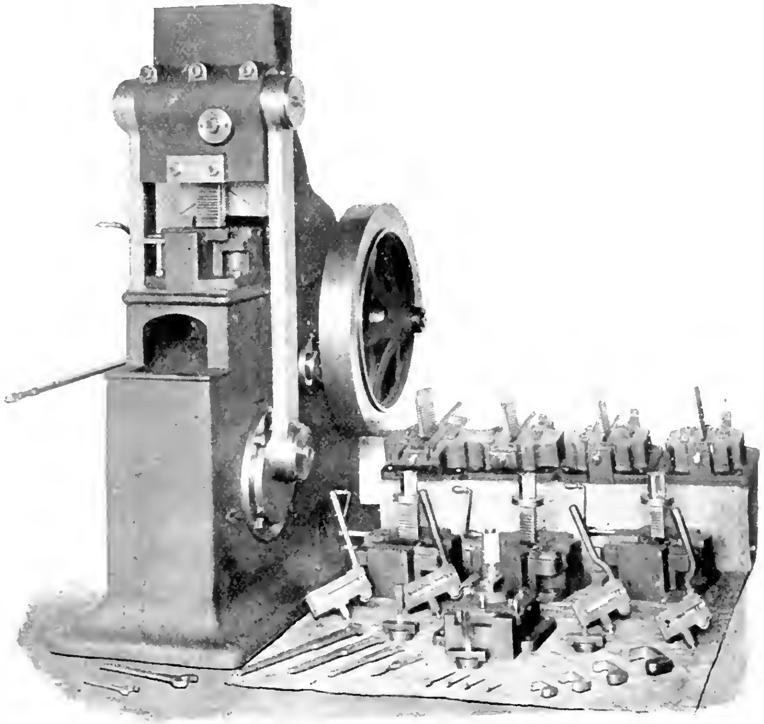
By Horace L. Arnold.

IV.—THE IMPORTANT PROBLEM OF TOOL EQUIPMENT.

NO engineer or superintendent should trust to his own knowledge or past experience in the use of tools as a guide in making extensive purchases of new plant, without first correcting his own conclusions by a careful and extended observation of recent installments in similar lines. The successful engineer of to-day must, it is true, be conservative, for the bold seeker after new and great things may win admiration and respect, but can seldom command confidence; his failures meet instant condemnation, while his successes require years of use before they can be minted with the stamp of popular approval; the consulting engineer and the successful superintendent must be conservative, but none the less is it the duty and the province of each to inform himself of the latest successful practice, and to remember always that no one shop and no one man's experience can ever include the best of everything. It would be unwise to equip a new establishment with untried makes of tools, no matter how great the promised gains in efficiency; but it is surely a greater folly to buy machine tools to-day because they were regarded as first in their class a few years since. There are many old shops in this country struggling against the certainty of failure ensured by the retention of old tools, once the pride of the establishment, carefully preserved, still perhaps almost as efficient as they ever were, but which should be instantly dismembered and go to the scrap-heap and the cupola. Yet it was thought, when those old tools were purchased, that they were not only as good as ever had been made, but that they were as good as ever would be made; and the purchaser who buys tools to-day without the knowledge which can be gained only by a personal inspection of the latest productions does so at the risk inseparable from all the ventures of ignorance. See what is in use, buy what is most efficient, no matter where or by whom the tool is built.

In other directions than machine-tool equipment it is possible to closely define some of the features of real economy.

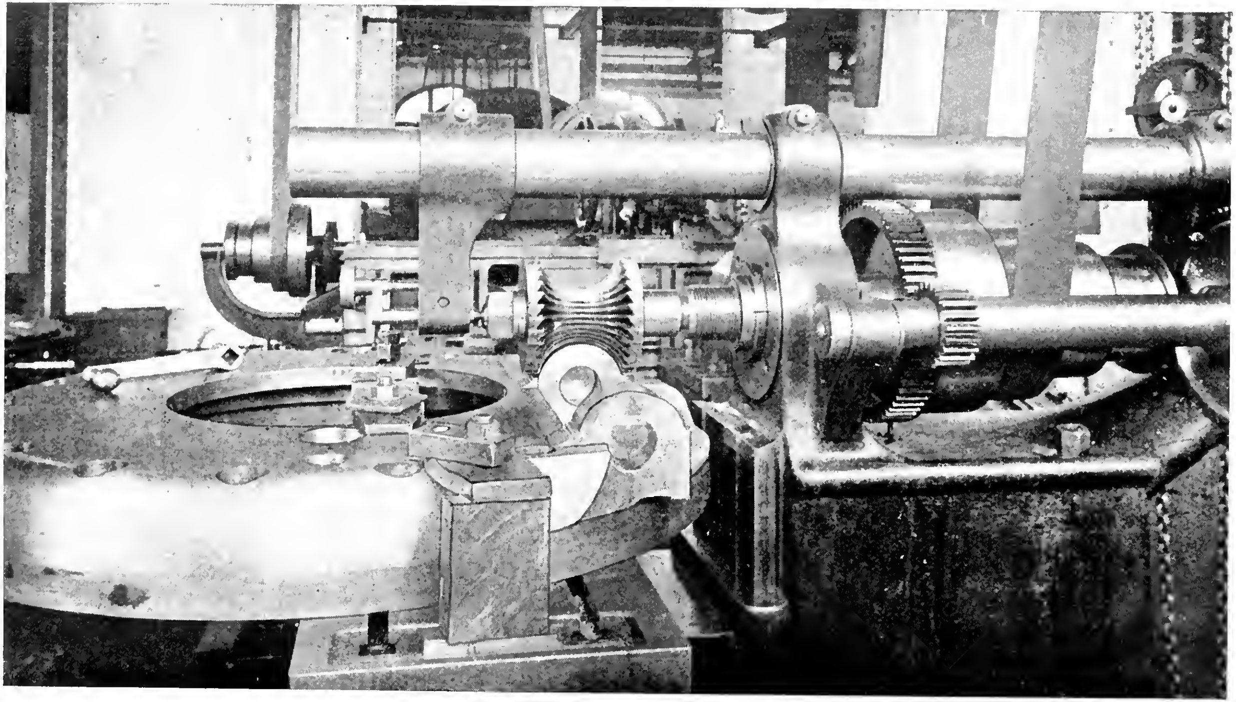
Up to a comparatively recent date American machine-tool designers regarded grey iron as a precious metal, to be saved and spared by all possible expedients. In the case of some tools—iron planers and boring mills, for instance—that day has gone. The value of mass is understood, and our planers and boring mills are as heavy as they need to be. In the points of easy handling and automatic movement, American tools have always stood in the front rank. American mechanics shun a tool which does not handle freely, and our engine lathes have probably been less efficient than economy demands, because of our adherence to the V-ways on which our lathe carriages travel. Up to 24″ swing our lathes are now being made effective. Over that size, we have in some cases, possibly, yet to adopt such details as will give our engine lathes the most economical service-possibilities. Our smaller sizes of lathes have been copied exactly by large European makers, who at first failed to equal our product, but now make work fully up to American standards. In milling machines we have always been leaders, and the value of the "Traversing Mill"—a powerfully-driven spindle having a large rise and fall on a heavy pillar which is either made to traverse on a large T-slotted finished sole plate, or is served by a large traversing table—is so well understood that this tool is now made a regular feature of heavy plant installment. As to the economic value of largely increasing the dimensions of the ordinary form of milling machine, there is still a question. Some very large milling machines have been built, but none of these machines have so far proved able to perform the prodigies of rapid metal finishing which, it seems, might reasonably be expected from them, and at this time a feeling of uncertainty is evident among the builders of very large milling machines. It seems highly probable that the past failures to reach the expected production have been due solely to weakness of the milling-machine frame and mill arbor, and the absurdly under-powered drive which has hitherto been furnished. The lathe and planer employ at the most only four or five tools cutting simultaneously: the milling machine may have forty or fifty tools in cut at the same time: the lathe and planer tools can be and are ground individually to the best possible shape for cutting; it therefore seems a perfectly demonstrated proposition that a milling-machine frame and mill arbor should be many times as heavy and stiff as the lathe or planer of the same surface capacity. Yet it is true that no milling machine has yet been offered which was much heavier in framing than lathes and planers dealing with surfaces of equal extent. Again, in the matter of power, a late large cylinder-boring machine, using four cutters in the boring-bar head, took all the power that could be transmitted by a good vertical double leather belt 5″ wide running 1132 feet per minute to cut over a surface 100″ diameter × 5/8″ wide,—say, 200 square inches in 1¾ minutes, or say 114 square inches of cast iron surfaced per minute by an expenditure of possibly eight horse power, spur gear reduction. The action of the tools in the cutter head of a boring machine is almost exactly the same as that of mill teeth milling a flat surface. Hence it would appear that a milling machine, expected to surface a



FINISHING BY BROACHING INSTEAD OF MILLING, PRATT & WHITNEY MACHINE, BROWN & SHARPE TOOLS.

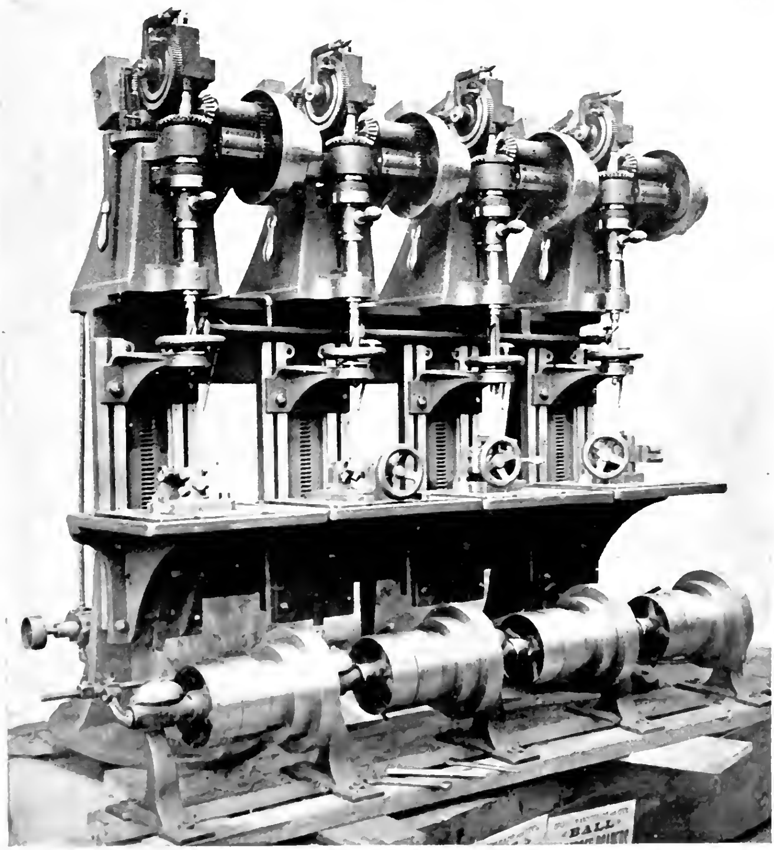
SOME OF THE BROACHES USED.

width of 30″ at the rate of 10″ feed,—300 square inches of cast iron finished per minute,—should have a drive capable of transmitting 20 or 30 h. p. easily, which has not yet been given in any milling machine brought to public notice. It is probable that all the mysteries of mill cuts will disappear, when milling machines are made as heavy, and driven as strongly in proportion to expected production, as other metal-cutting tools. In drilling there has been lately, under the forced production demand made upon the bicycle factories, an enormous increase in

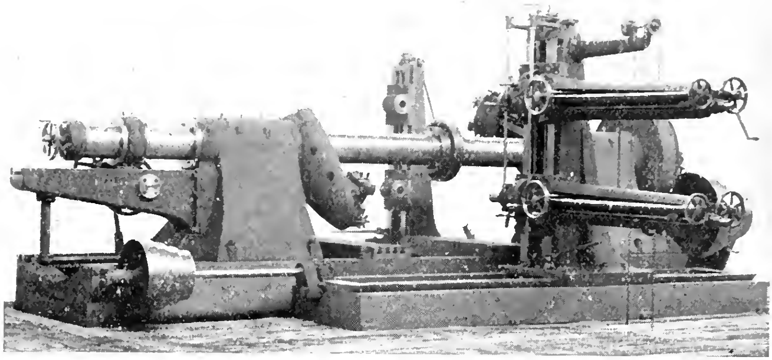


SPECIAL BREECH-COVER HINGE-MILLING MACHINE, WATERVLIET ARSENAL. BY PEDRICK & AYER, PHILA., PA.

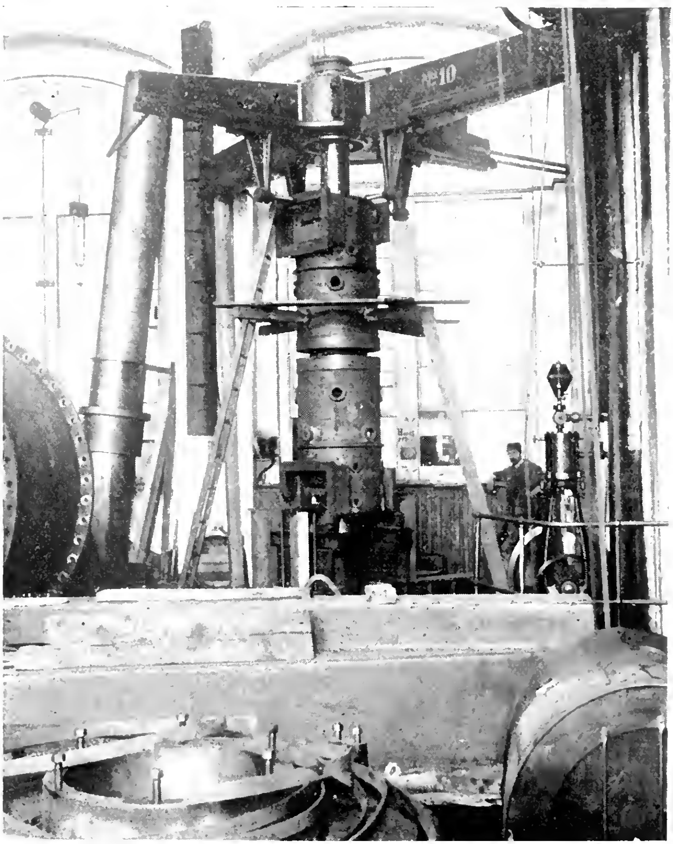
drill speeds, and a very great increase in drill feeds; the increased speed has been accompanied by a somewhat diminished chip thickness, but the effectiveness of the drill has been fully doubled within a short time, and the practice of "banking" drilling machines—that is, placing them closely in rows, so that one man can attend a number of machines—has reduced the cost of drilling, where the operation is continual, to a very small fraction of what would have been held as good machine-shop practice a few years since. The purchaser who is not fully informed as to the practice of the bicycle factories is more likely to buy under-powered drillers than any other machine tool. A drill feed of 1″ per minute with a $1\frac{5}{16}$″ drill in steel forgings is something so far be-



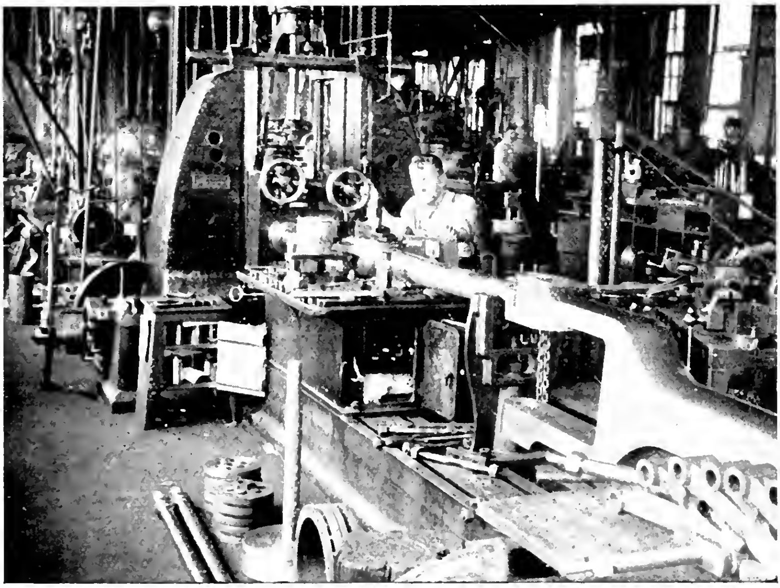
BANKED DRILLERS. BY BAKER BROS., TOLEDO, OHIO. CAPABLE OF DRILLING 1″ PER MINUTE, $1\frac{5}{16}$ HOLE.



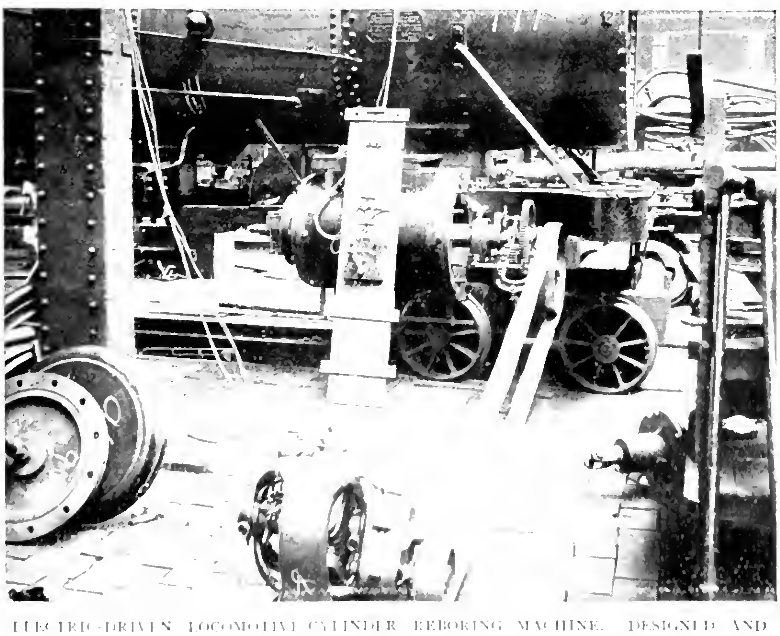
NILES SPECIAL CORLISS CYLINDER-BORING MACHINE, WITH 3 BORING SPINDLES.



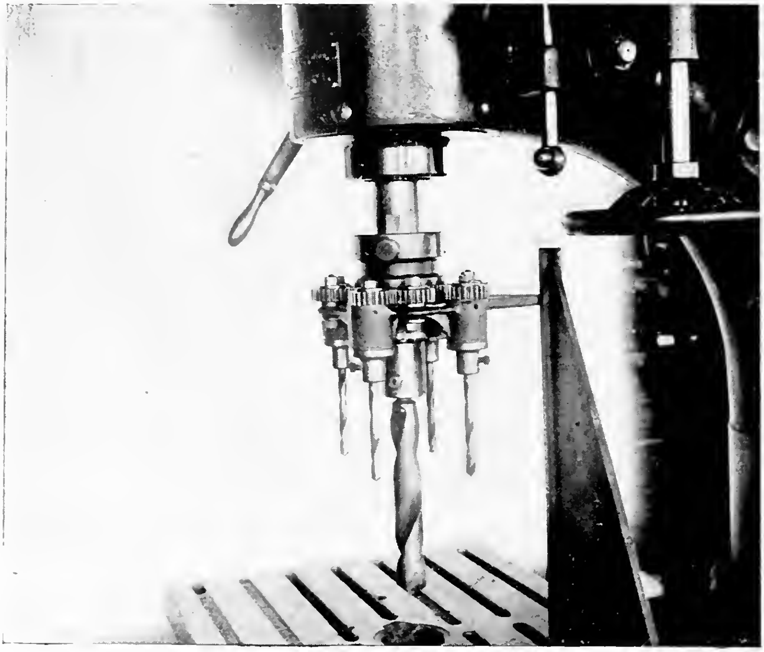
DE LA VERGNE CYLINDER-BORING MACHINE, TO BORE 20 FT. LONG X 120 INCHES DIAMETER. BUILT BY DE LA VERGNE REFRIGERATOR CO., PORT MORRIS, N. Y.



NEWTON DOUBLE ADJUSTABLE SPINDLE HORIZONTAL DRILLING MACHINE FOR CONNECTING ROD ENDS. DE LA VERGNE SHOPS. BY NEWTON, PHILA., PA.



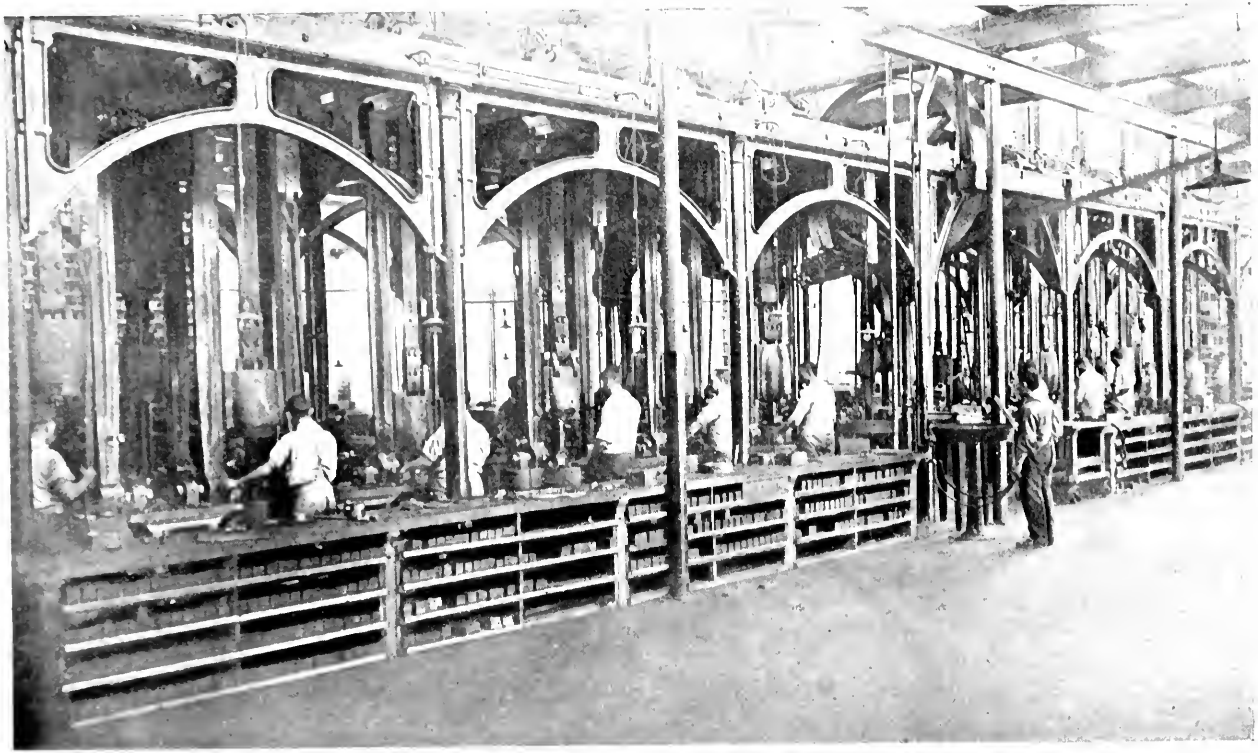
ELECTRIC-DRIVEN LOCOMOTIVE CYLINDER REBORING MACHINE. DESIGNED AND BUILT BY C. M. & ST. P. RAILWAY, MILWAUKEE SHOPS.



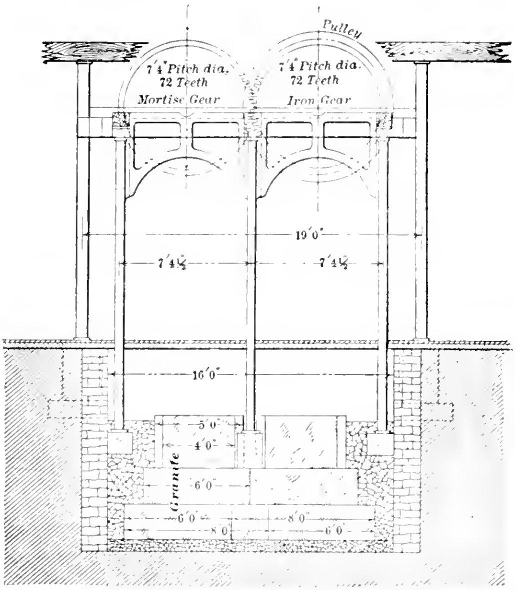
5-SPINDLE DRILL ATTACHMENT. CHICAGO, MILWAUKEE & ST. PAUL RY. SHOPS, MILWAUKEE, WISCONSIN.

yond ordinary machine-shop practice that few superintendents would demand a tool capable of such a performance.

The steam hammer was so late in making its appearance that the eager demand for its best services led to rapid development, and it very quickly reached such conditions of effectiveness and satisfactory detail as to leave little to be desired. With the drop hammer the case is somewhat different. There was, and still is, an entirely erroneous theory that rigid drop-hammer foundations are destructive to the machine, and that a certain degree of elasticity must be had to ensure successful drop-hammer practice. The magnificent bank of drop hammers on massive cut-stone foundations designed by Mr. Bogle and installed by the Gorham Company at its factory in Providence, R. I., fully demonstrates the propriety of placing the drop-hammer anvil on a perfectly rigid foundation. The Gorham experiment has been in most successful operation for a number of years, and conclusively proves that a rigid drop-hammer foundation not only vastly increases the effectiveness of the hammer blow, but reduces drop-hammer breakages to the lowest limit.

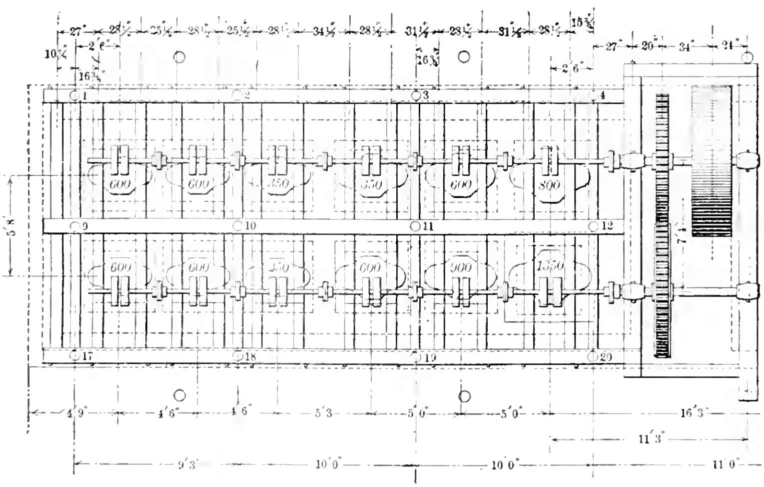


GORHAM MFG. CO. DROP-HAMMERS, UP TO 1300 LBS. DROP WEIGHT.



* GORHAM DROP-HAMMERS: END ELEVATION.

The electric travelling crane is an indispensable adjunct to the heavy-machine floor, is perfectly well known, and is mentioned here only to avoid a possible charge of inadvertence. For lighter work there are hand travelling cranes, some of which weigh as little as two tons each, and can very easily handle five-ton pieces. There are also valuable systems of overhead railways provided with hand chain hoists, which are well known and widely used. For the foundry floor practice varies: the heavy foundry may well have its moulding space wholly covered by an electric travelling crane. Electric jib cranes may be used on the foundry floor, each one covering a space



* GORHAM DROP-HAMMERS: PARTIAL PLAN.

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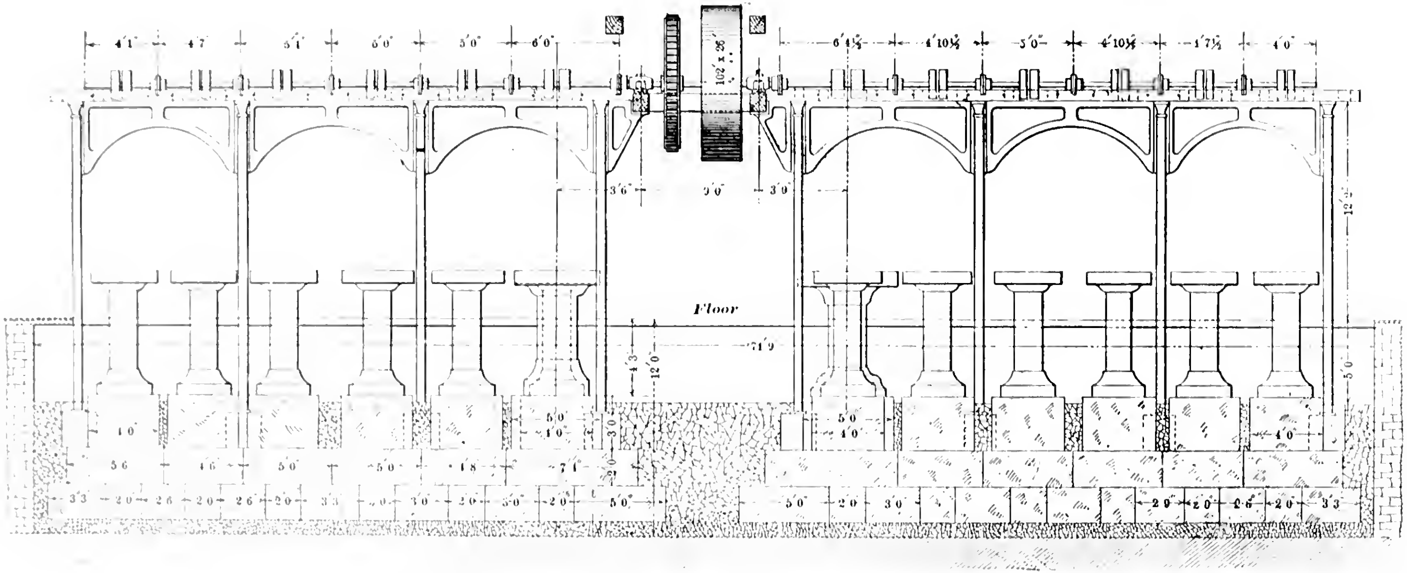

GORHAM MFG. CO'S HAMMER FOUNDATIONS. DESIGNED BY J. M. BOGLE, SUPT.

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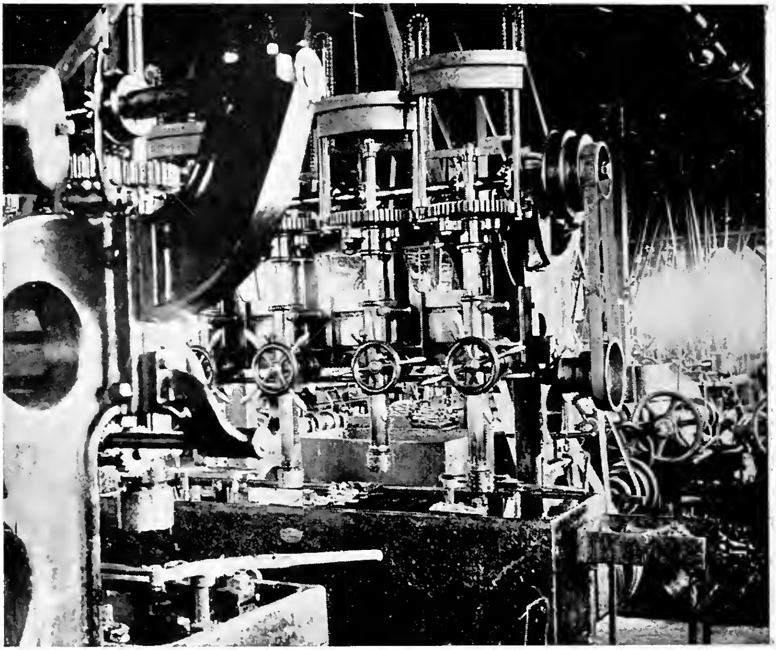
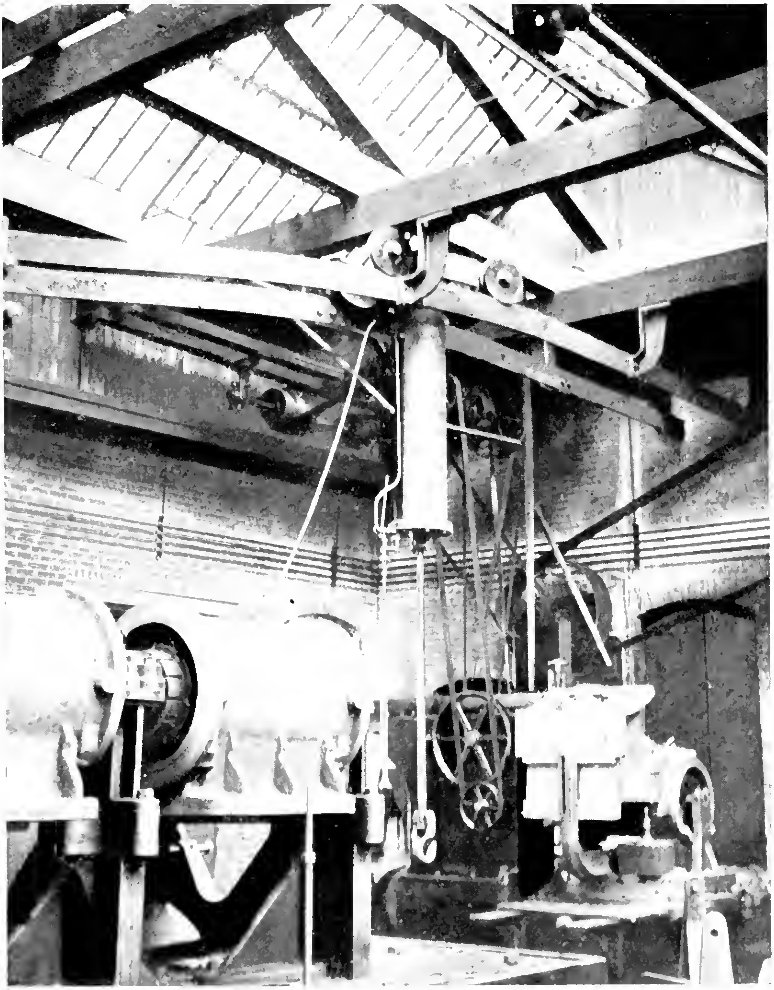


VAUCLAIN'S TAPER-BOLT TURNING MACHINES.

One man turns 1000 to 1200 taper locomotive bolts 8 inches long in 10 hours. Work is submerged in oil-tanks. Baldwin Locomotive Works, Philadelphia, Pa.

occupied by one gang of moulders, and in very many lines of foundry work the air hoist is indispensable, especially in connection with moulding machines for the heavier forms of machine-moulded work, as on the Deering ground-wheel floor, and the Milwaukee Harvester Company's Reaper Frame floor, where Mr. G. H. Schulte, superintendent, has reduced the per ton labor cost of the heavier parts of reapers and mowers from $6.60 to $2.40, by the use of moulding machines and air hoists, while the piece-work earnings of his moulders are now a little more per week than they were at the $6.60 cost rate, and their work is easier. Wherever the continued use of a piece of grey iron is tolerably certain, the special moulding machine should be employed in its production; the lowest foundry labor cost cannot be reached without the use of moulding machines and the air hoist.

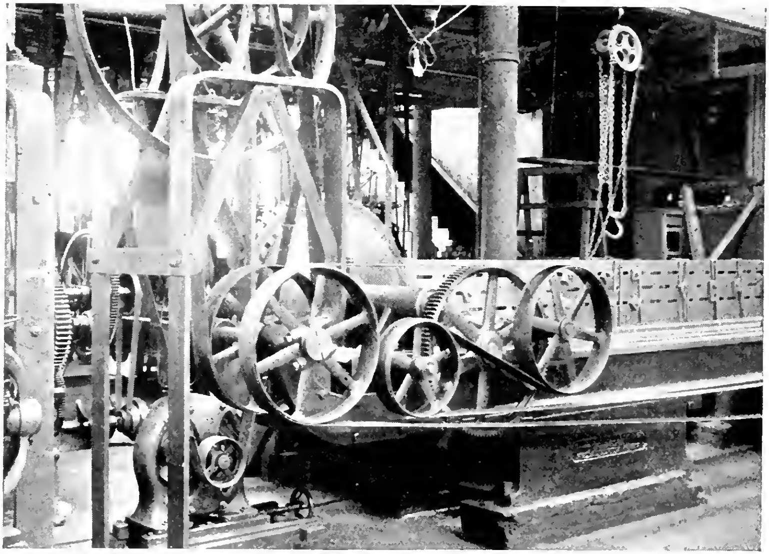
The air hoist may also render very valuable service on machine floors covered by heavy travelling cranes; the cost of each air hoist is very small, and it will often save time which would be lost while waiting for the big electric crane. It is peculiarly adapted to "rolling

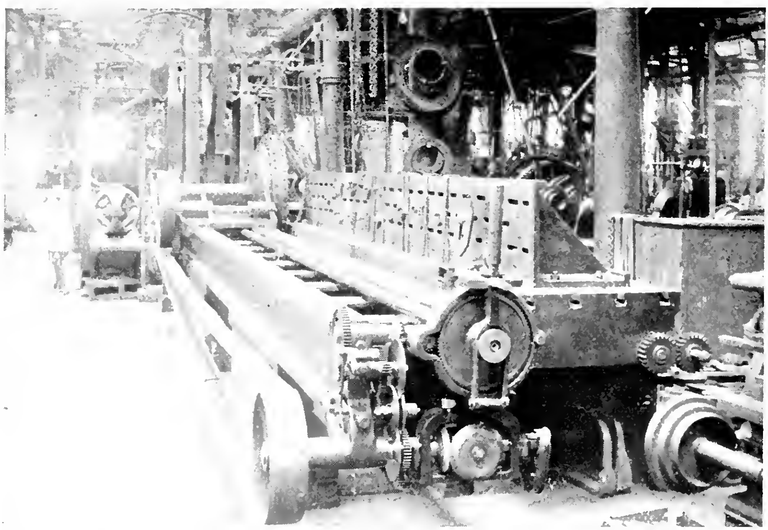


AIR HOIST, CYLINDER ROOM, RHODE ISLAND LOCOMOTIVE WORKS.

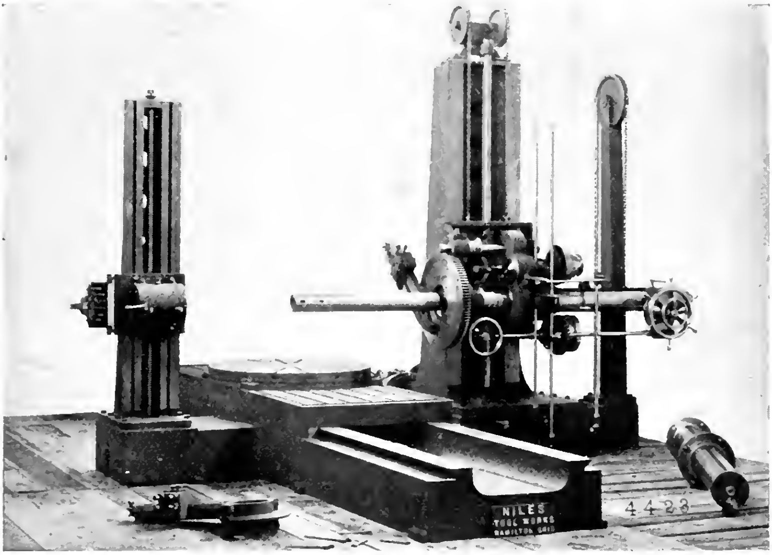
over" and to cope lifting, because of the softness and absence of jar in its action. It is also a great labor-saving aid in setting work on heavy planers, the air hoist in this case being a regular part of the equipment of each tool, always at hand and ready for use by the individual workman, who finds it far more efficient than a gang of helpers, who in many instances have to be collected at some loss of time.

The substitution of mechanical lifts for the moulder's muscle is the one marked feature of improved foundry practice. Jib cranes,





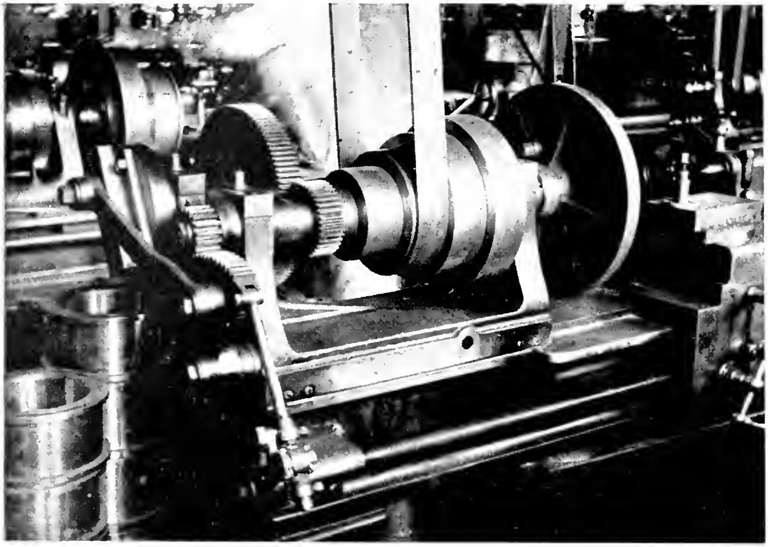
TWO VIEWS OF SELLERS LOCOMOTIVE DRIVING-BOX SURFACING-MACHINE. BALDWIN LOCOMOTIVE WORKS, PHILA., PA.

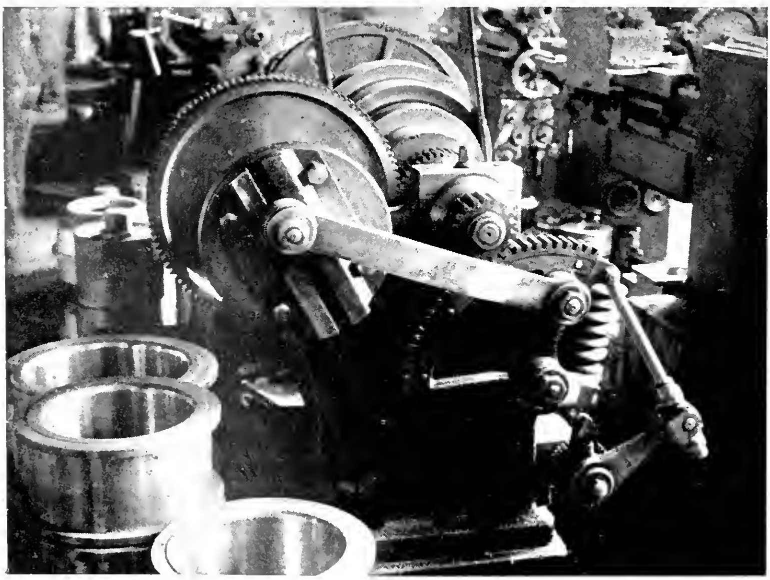


HEAVY TRAVERSING MACHINE: NILES TOOL WORKS, HAMILTON, OHIO.

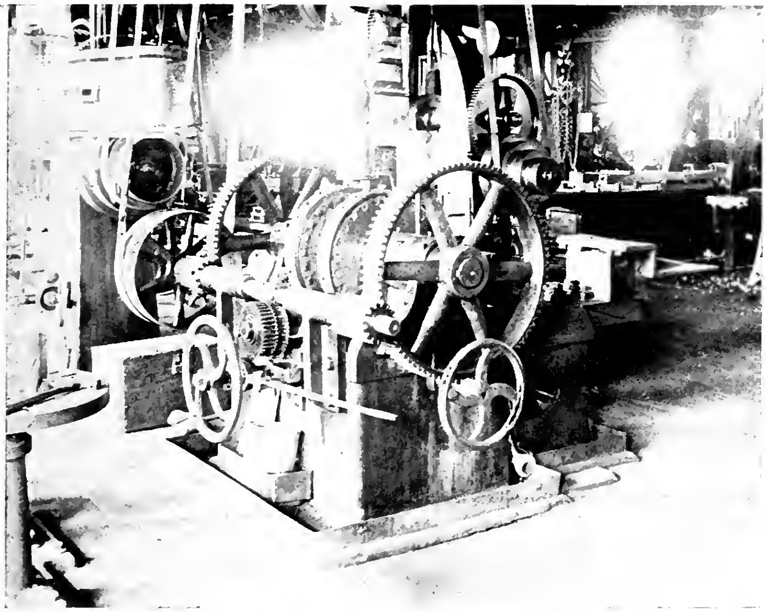
travelling cranes electric in all cases where power driven, light overhead ladle carrying devices, and air hoists variously hung, are the noticeable modern innovations.

At the present time electric driving of machine tools is in a transition stage of development, which may end in complete systems of individual motor driving, or in mixed systems where separate motor units of not very large capacity drive short lines of shafting. There seems at present a strong probability in favor of a final verdict for the individual system, where each tool is driven by its own independent electric motor. There is every reason to hope that all overhead shafting, pulleys, and belting may disappear from the machine shops, as these hitherto indispensable elements of power transmission are dirty and expensive light-obscuring annoyances; the sooner they go, the better for all concerned. It is possible that the next five years will suffice to nearly abolish the leather belt in American practice. The rope drive, so long and favorably known abroad, is probably cheaper, and in every way better, than belt driving from the engine to the dynamo. A very recent installment is that at the Edison Power house, Paterson, N. J., where the arc light dynamos are rope-driven from vertical Ball and Wood engines. Another example is to be seen in the 1896 addition to the Monarch cycle shops, Chicago, where the line shafting of the multifloored extension is rope-driven. Line shafting and leather belting possibly are still debatable points, with the probabilities, however,

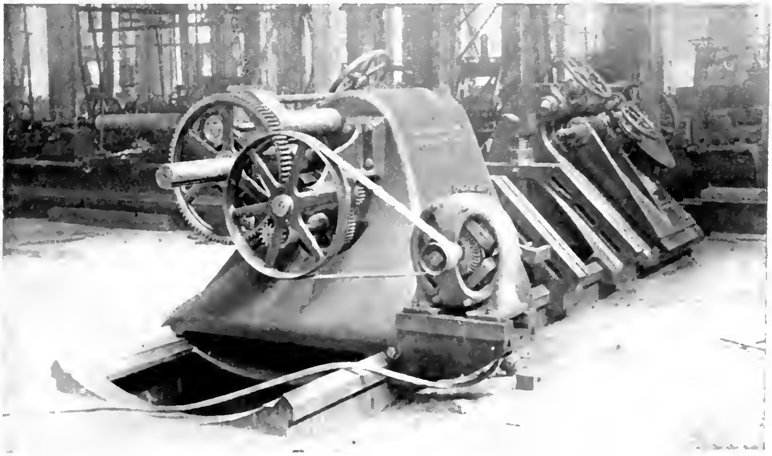




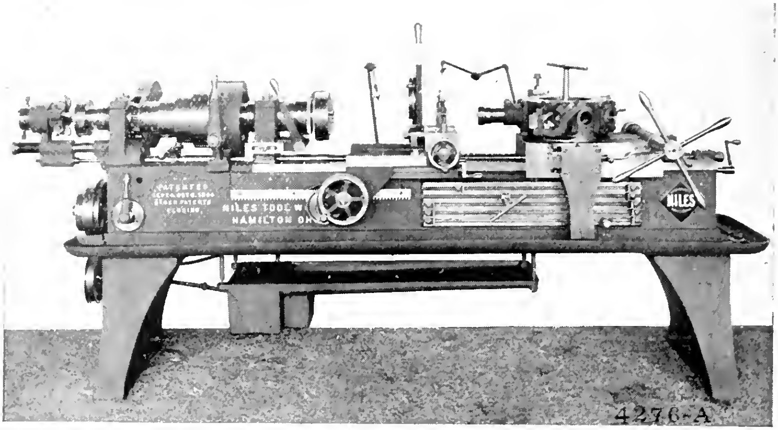
OSCILLATING LATHE FOR ROUND-END CONNECTING-ROD BRASSES.
DESIGNED AND BUILT BY DE LA VERGNE REFRIGERATOR SHOPS,
PORT MORRIS, N. Y. FRONT AND END VIEWS.



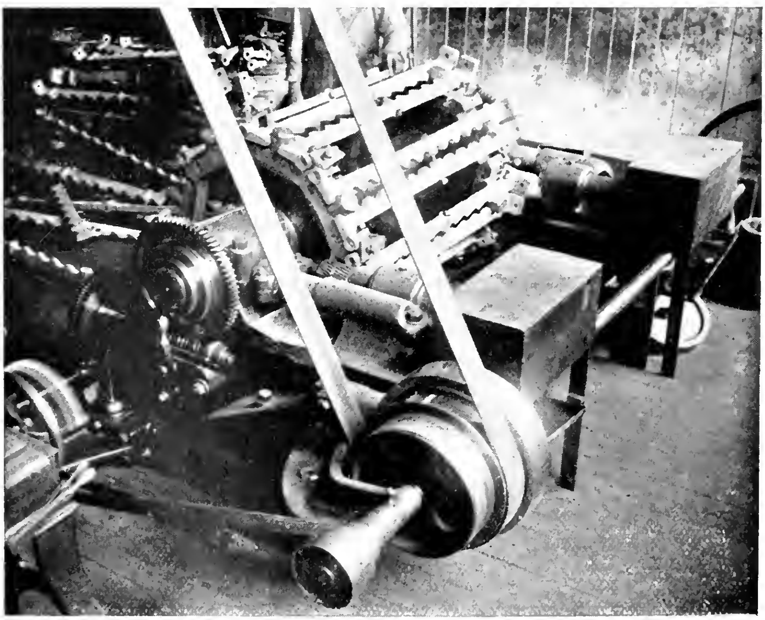
SPECIAL CONNECTING-ROD STRAP SURFACING-MACHINE. DESIGNED AND BUILT BY BALDWIN LOCOMOTIVE WORKS.



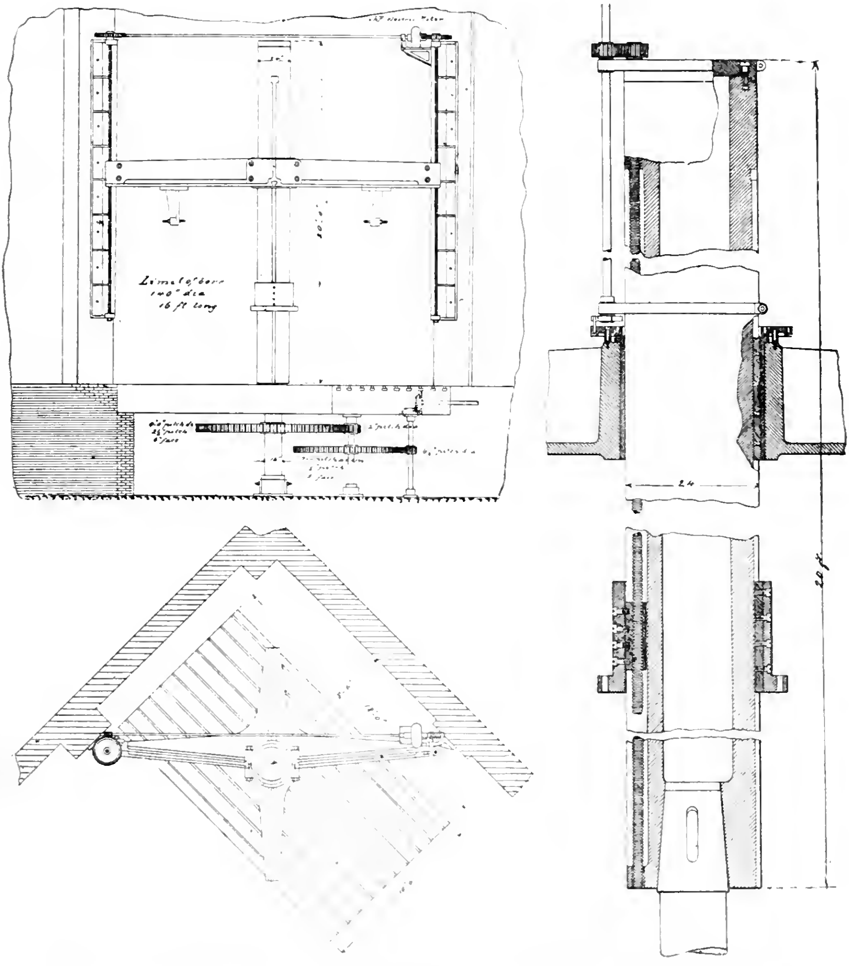
ELECTRIC-DRIVEN QUARTERING-MACHINE, BALDWIN LOCOMOTIVE WORKS. BY BEMENT & MILES, PHILA., PA.



NILES TOOL WORKS HEAVY TURRET MACHINE.



NEWTON SPECIAL DOUBLE-MILLING MACHINE, FOR FINISHING ENDS OF PIPE-STANDS TO LENGTH. DE LA VERGNE SHOPS. BUILT BY NEWTON, PHILA., PA.



DE LA VERGNE CYLINDER-BORING MACHINE, ELEVATION AND PLAN AND SECTION OF BORING BAR.

vastly in favor of a condemnatory final verdict against both, although no sufficient time test has yet been given individual motor driving to make its future use an absolute certainty.

Artificial lighting by candles, lamps, gas, and incandescent electric lights, all of which are easily within the personal experience of machinists still in service, is faulty. Arc lights, supplied with large concave reflectors underneath, so that all the rays are first reflected upward, will, in connection with white overhead work, light a machine floor so that the change from day to night will not be noticed by the workmen. The De La Val shops are so lighted, the whole interior of the shops being painted with white asbestos paint. This method of lighting leaves absolutely nothing to be desired.

Ventilation should be, possibly, wholly by artificially-induced air currents. It is not desirable to pierce the side walls of workshops with windows. Undoubtedly the first cost of artificial ventilation is less than the cost of time lost by workmen in opening and shutting windows to gain an imperfect air circulation, which at best annoys some hands as much as it pleases others. A closed building even of very great extent can have all of its contained air changed as often as needed, and its temperature kept as desired, by the use of the blower. It is but rarely that a room perfectly ventilated and not exposed to the direct rays of the sun needs artificial cooling to make it tolerable to workmen; it seems likely, however, that entire control of workshop temperature, in cooling as well as heating, would be found economical. In the case of, say, five hundred workmen, saving a very small loss of efficiency in each due to high temperature of the shop would make artificial cooling an economical practice. The drawing-room should certainly be artificially cooled, as very few men are capable of continued mental effort in a temperature above 80 degrees.

There can be no question as to the desirability of a certain degree of cleanliness, education, and self-respect on the part of the workmen. The dirty slouch covered with machine grease is not the ideal machinist. But the moment a man has been cultivated to the point of personal neatness, he begins to take offence at enforced intimacies with unclean things. It is true that habit will lead to toleration of repugnant conditions. A modern office-building is precisely like a shop in one of its conditions: it must acceptably house a vast number of workers during working hours. Certainly no office-building which provided only the ordinary machine-shop facilities for privacy could find tenants. It is true that there is a current belief that machinists are of coarser clay than clerks and office-workers, yet it seems not improbable that a regard for natural decencies might be inculcated even in the rude nature of the mechanic by a few generations of service in shops where decency was made possible. There is also a belief that machinists, boiler-makers, moulders, and blacksmiths must be coarse and brutal to be effective workers, and it is probably true that education and refinement will lead a machinist to look with disfavor on such a job as putting a repair crank on a screw shaft in the hold of a tramp steamship in company with tallow candles and dead rats washing about in the bilge water, which is certainly not an agreeable all-night occupation. But the experience of all foremen will probably sustain the assertion that, in emergencies, his neat and intelligent men serve his purposes best, and closets should be such as not to offend such workmen, either by enforced association or lack of ventilation.

Refectories, or eating-rooms, are in some places accepted by American workmen. Libraries, reading-rooms, and free shop night-schools are of little use, because few men care for books, and those who do commonly own them and prefer to use them in solitude. Also, the workman who wishes to study at night commonly prefers to pay for attention he seldom receives at a free school. Men who seek an education after they have reached the journeyman's estate are rare, and are disposed to shun the crowd and work alone. The Straight Line Engine Shops at Syracuse went to some trouble and expense with a reading-room, which is now used as an odds-and-ends store-room; the hands would not enter it. The Baldwin Locomotive Works has, I believe, something of the sort. Night drawing-schools connected with the shop, and giving instruction in mechanical drawing and mathematics at a nominal tuition cost, are often largely attended; and such a department should be an adjunct of the drawing-room in every large establishment, as the education therein imparted is of distinct value to both the workman and the management.

The necessity of the tool-room and small-tool check system are too well known to need more than mention. Some large shops still permit workmen to grind tools to suit themselves. The cutting edges of tools, excepting those of tool makers and piece workers, should be under shop control; this can be the case only where tools are ground in the tool-room. In a large establishment each department must have its own tool-room and grindery, and tool system generally, as the requirements of departments differ, and distance forbids the use of one tool-room for all.

Time-keeping, either by the check or the individual clock-key system, may be said to be established. The check alone can be made to answer every purpose very cheaply, and has as few objectionable features of use, perhaps, as any known method of recording the arrival and departure of hands. With the form of shop proposed in the last paper, the check-boards can be lifted to the gallery floor for the replacing of the checks, so that the check-boy need not go down into the shop departments.

A full telephone equipment is, of course, indispensable to any large establishment. In the Deering Reaper Shops, Chicago, the central telephone office is located at one side of the entrance room, and the girl in attendance is usually able to give information as to the whereabouts of most of the officials who meet strangers.

An application of the common hotel annunciator might be made in connection with the telephone system. There are seldom more than, say, ten officials whose duties may call them to many parts of the works. Place a row of, say, twenty push buttons, two for each of these wandering officials, at the telephone stand or entrance of each department; these buttons wired to annunciators in the personal office-rooms of these officials, and to any other desired point; probably the telephone central office and office of the general manager, in addition to each official's own office, would be enough. Each annunciator would have under each official's name numbers indicating every shop department, and an "In" and "Out" legend. Supposing Mr. Smith to enter his own office, he pushes the button, and announces his presence in the works to the general superintendent, and to the central operator; when he leaves his room, he pushes a button which covers his own office-number on all the annunciators; upon entering another department, he pushes his individual "in" button, and is duly announced as being at that location; when he leaves, he pushes his individual "out" button, and thus records his departure on the annunciators. By this simple and inexpensive means many hours of valuable time can be saved every day in any large establishment, as the exact location of every prominent man in the place whose duties cause him often to leave his own apartment can be constantly known by the central operator and the manager.

The importance of this proposed annunciator installment is really very great. It would earn its cost many times over every year, as it would supply a now missing link in that instant communication of individuals which is indispensable to the greatest production with the least cost.

The question of special machine-tool making affords scope for the exercise of mechanical talent and business prevision of the very highest order. A special machine tool is absolutely worthless, except in the production of the one particular piece for which it was made. It is always expensive, and it is always to some extent a hazardous venture.

The special machine tool may be of any size and weight,—from a few pounds to many tons. It may have any number of tool-carrying spindles,—from one to hundreds. It may simply drill, or it may drill, turn, bore, plane, ream, mill, tap, and thread. It may be and do anything: it may take any form: it may combine many operations, all executed without changing the location of the piece on which these operations are performed, or it may be the subject of the most minute subdivision, each machine being reduced to its lowest operative terms, and the work being transferred from one machine to another, either automatically or in bulk.

Generally speaking, where small articles are manufactured in vast numbers, like wood screws or cartridge shells, the better practice is to divide and subdivide the duties of each special machine to the lowest limit; where the articles made are fewer in number. and the relative location of cuts is a matter of supreme importance, it is better to locate the work but once, and perform the operations by means of separate tool-carrying agents. A sewing-machine bed or an engine cylinder is best finished at one setting from geometric or living-axis-guided cutting-tools, instead of trusting the uncertainties of resetting to cuts already made.

Special tools should be introduced into any manufacture the instant that sale for the product is assured, because they reduce cost, sometimes to an incredible extent, and improve quality. A manufacture which is in danger of death from close competition may rise to instant control of the market by venturing sufficient capital to reap the full benefits of special-tool use. A machine frame which cost $10.60 to finish at piecework prices, with ordinary shop aids in the way of jigs and gages, was finished for 38 cents by the use of a special tool, and an intelligent introduction of special machinery in the entire factory put a balance of $35,000 on the right side of the ledger at the end of two years from the inception of the special-tool building, as against an actual loss under the previous system, which was thought fairly good. The well-informed superintendent has this vision of special tool-economy and supremacy constantly before his eyes. He has the strongest possible reasons for the building of special tools, and he also has the strongest possible reasons for continuing the old order of things. He may cause special tools to put the establishment he controls on the top wave of prosperity, or he may put the safe, slow-going, small-profit-paying concern into bankruptcy. Yet there can be little doubt that the error of the wise superintendent will always be on the side of special tools and low labor cost. Special tools for producing machine details are now a regular part of shop equipment. Screw machines, turret chucking machines, special planers, flat turret lathes, and engine lathes provided with specializing attachments are bought in the open market, and are of established good repute. Shall the manager content himself with these minor aids to cheap production, or shall he boldly produce expensive special tools, which will reduce his labor cost on large pieces to a mere fraction of the best his best men can do with ordinary lathes and planers?

THE ARCHITECTURE OF HOME-MAKING.

By Charles E. Benton.

THE art and instinct of home-building is shared with man by many other animals, but this of itself can hardly be dignified by the name architecture. It is only when an effort is made to add to, or embody in, the structure some expression of the beautiful that the art becomes allied to the fine arts, and in time takes its place in their front rank.

But, however far progress may go on this line, it is evident that it must never lose sight of its primary concept; that it rests upon utility as its basic principle is as certain as that "the line of beauty is the result of perfect economy."

But there are utilities and utilities. There is the utility of the roof that shall deliver the rain-fall to its proper place, and of walls that shall debar the entrance of the frost-king; but there are higher utilities than these. The family life is to be protected, influenced, and developed, and in this the work of the architect is that of one who constructs environments, favorable or otherwise, depending upon his mastery of the deep significance of his art.

It has been well said, by a prominent writer, in reference to architecture, that the interior is its life and the exterior is but the expression of that life, and that we must build from the interior outward. This contains a hint of the truth; but, as it refers to only the building itself, it is evident that the full light had not risen upon the author. To build rightly from the interior outward requires that we shall begin at the family life and make the interior of the house the expression of that life, and the exterior the outward form of that expression. With this initial understanding of the subject is there occasion for wonder that the home-making instinct is suffering from atrophy in some instances, and in others is compelled into so many ready-made misfits that its present condition seems scarcely less a deformity than the famed foot of the Chinese lady? A century ago the house of an American family was, like the ancient baronial castle, a growth rather than a creation. The young couple began life in an establishment proportioned to their means, and, as the means grew and the family increased, the house changed and grew until, in its way, it became an expression of the family life; nay more, it often embodied in its additions and peculiarities of architecture the whole family history, as it were, in hieroglyphics; not the creation of a professional hour, but the embodiment of a lifetime of thoughts and necessities.

It is noticeable that these household temples of a former generation, only a few of which remain in this country, retain a rare architectural charm all their own, but of so elusive a character that the modern architect seeks in vain, with dormers and reentrant angles, odd floor levels and broken roofs, to make it his own. As well try to nail the sunbeam to the floor or entrap the fairies whom the good dames saw of moonlight nights dancing under the old oak trees on the lawn. The abject failure of such efforts was well expressed by a gifted Swedish lady, who visited this country some years ago. While sailing up the Hudson, her companion pointed out a battlemented structure of stone, exclaiming:

"Do you see? A castle!"

"Ah!" she replied, "but it is a *very young* castle."

All such attempts fall short of complete success,—success in its best sense,—because of the very patent fact that present life is not fitted to appear in past forms. I am not writing for that very limited class of prominent citizens aptly termed the "vulgar rich," who desire nothing so much in a residence as ostentatious display. They have their reward. But for those who desire harmony of details it is worth remembering that battlemented walls, with their alternate solids and open spaces, were made for archers' positions of offence and defence, and that, when incorporated into the architecture of a modern, peaceful home, they become entirely expressionless, or, at the most, can be classed only as rudimentary survivals. If it is really desired to give some expression of combativeness to a place which should be the seat of love and peace, it would be much more appropriate to put an electric disappearing cannon or a Maxim machine gun upon the lawn. We are wont to forget, in our admiration of past forms, that the men who planned and built those structures were, in their own day, men of the latest thought,—up-to-date men who most successfully applied their means to the then present needs. Let us, then, sincerely admire the beautiful forms in which a former life found fitting expression, but avoid the mistake of assuming that they are models for present needs.

If the soul doth build its house, as the philosopher avers, in an equally true sense does the family, when opportunity may be had, build its house also. Yet, while the family builds its home, the converse is equally true,—that the home ofttimes shapes and moulds the character of the family: so, if the teachers of other arts and literatures have their burden of responsibility, in still greater degree must the priesthood of our own cult know that they also are their brothers' keepers.

Character is an edifice, artificial to some extent, built up through the ages from a foundation of inheritance which reaches down into the sources of our civilization.

Each cube of virtue is grasped first by conscious effort and held to its place until, by the hardening cement of habit, it is fixed, itself becoming foundation for further attainments, and effort being released to go forward to further accomplishment.

In the plastic period of childhood the most strenuous builder of character is the family life. How important, then, it is that the architecture of the home should be such that this influence may have its freest and most beneficent development! I have in my mind a certain house of imposing exterior, but so curiously arranged within—or, rather, misarranged—that in not a single room is there a place where the entire family can unite socially; not a broad table is there within its walls where the latest papers and magazines with the newest books can be so laid as to be conveniently accessible. It is true that much of this effect is due, in this instance, to a system of housekeeping which has for its guidance a false objective,—a worship of house rather than household. Such houses must nullify, to some extent, the best efforts towards character-building by means of family influence, for the reason that they are not unifying, but disintegrating, rather, in their influence, dissipating the affections and energies instead of concentrating them. If these things must continue, 'twere better far that our furnaces and steam-heaters were cast into the sea, and we were driven back to the ancient fireplace, which, with all its discomforts, compelled the whole family group to its radiant circle. Under its concentrating influence the family life was intensified, and the strenuous virtues acquired deeper strength and vitality.

We may not doubt that the fireplace of the great family-room of our forefathers is entitled to a prominent place, with the Bible and the public schools, in that group of dominant influences that did so much to form an American type of character. I recollect, even in my own day, a great room spanned with sagging beams and containing unestimated cubic feet of breathing space, and I can scarce credit my memory as it enumerates its vast contents. The magic influence of that room was such that wholesome character was developed and maintained, and five generations have gone thence into the world in succession, making its potent influence for the right felt in many communities.

No one rightly values his profession who does not desire to bring it into line with eternal rightness in all its bearings; and, in order to do this in architecture, we must arrive at a right estimate of comparative values. Much is said about the responsibility of the architect as an educator of the public taste, but it seems trivial indeed compared with the far greater responsibility resting upon his shoulders as one who has the making of the mould, so to speak, in which is formed the future character of the community.

"The friction of daily contact with the world grinds character to its keenest edge, but upon home influences it must depend for its temper, without which its keenness would be, at best, but a crumbling edge."

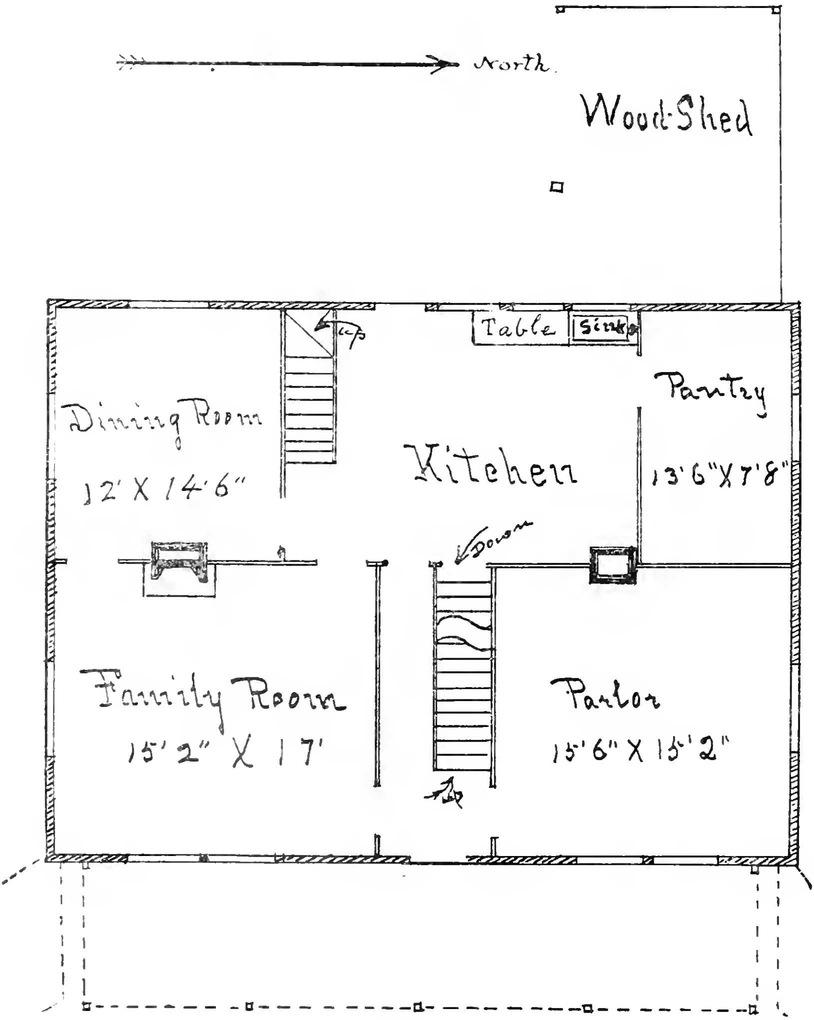
It is not within the scope of this article to treat, in fulness of detail, of the mechanical methods by which just results may be obtained, but, rather, to point out that the profession has a deeper significance than perhaps many of us have yet reflected; that it is entitled to an equal standing with those other professions that are considered to hold the key to the community's welfare. The means to be employed are as varied as are our resources. The grouping of rooms by which privacy and quiet may be secured where it should exist is to be duly considered, as well as that greater desideratum, the opportunity and encouragement for joyous sunlit family intercourse, the great healer of the world's sorest wounds.

As has already been hinted, in the application of architectural principles to home-building the first prerequisite is to know the life of the family which is to use the home, and equally the means at disposal for the purpose. These are the two determining factors, and, thus considered, the subject can not be thought to properly include millionaires, as their means are practically unlimited, or the very poor, since they have no choice in the matter, but must find shelter from the elements as best they may. But for the great mass of useful citizens between these two extremes,—the earning, renting, owning, "easy," and wealthy,—both these factors must be considered.

It may be surprising to learn that professional architects have given comparatively little attention to the homes of a very large class of citizens. I refer to farmers,—more than half the population of the United States. In conformity with their method of life nothing more befits the farm-home than directness and simplicity combined with generous space, and the best success is obtained by not clinging too closely to the customs of metropolitan life. The farm offers wider variation in regard to means and family customs than is to be found elsewhere, but the same rule must prevail,—that the house should conform to the best life of the family whose home it is. To illustrate this I have selected the farm-house shown in the plan on page 700.

In this instance the size of the family and the limited means at its disposal made it imperatively necessary that the utmost available space should be enclosed at the minimum of cost.

An easy error to have made in this plan, and one which would probably have been made if the matter had been left to the country carpenter, would have been to include a re-entering angle at the south-west corner, the effect of which would have been to eliminate the dining-room and one chamber without in the least lessening the expense of the building. It may be objected that the work of the household is here given too central a position, but it must be considered that, as the family keeps no servants, work—and for the female members

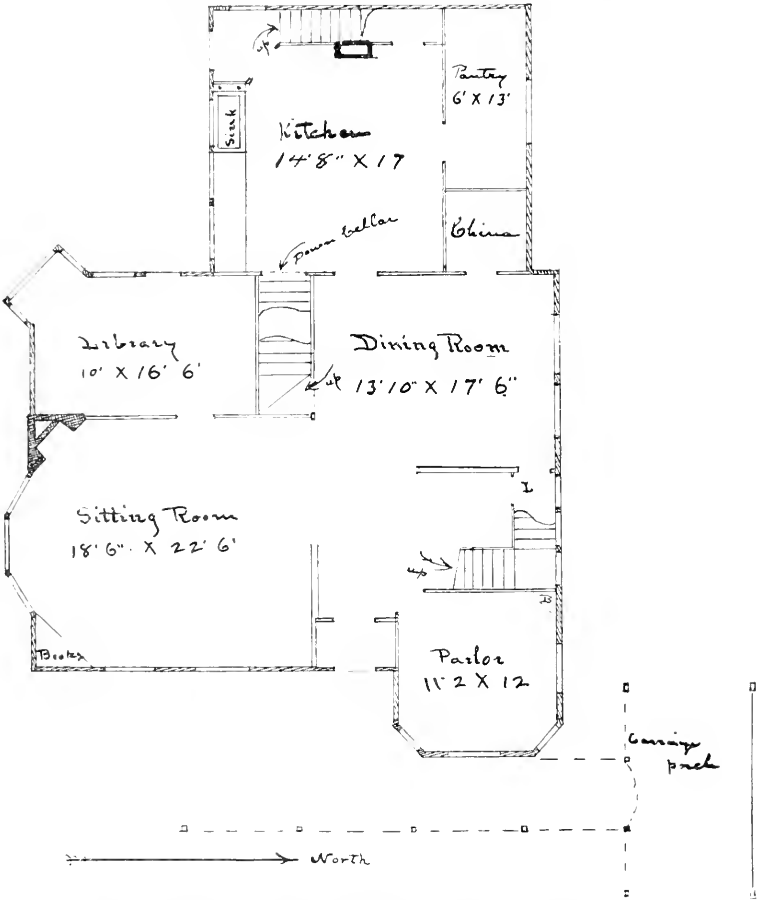


PLAN FOR A SMALL FARM-HOUSE.

household work—is the central fact in the family life; and this acceptance of the fact bestows a certain dignity which could be attained in no other way. In the sphere of utilities the house seems especially adapted to the needs. The location of the wash-room and laundry in the basement removes the coarser work from the inhabited rooms, while the central position of the kitchen enables the labor to be performed with the fewest possible steps. It will be noticed that every room in the house receives its full quota of sunshine at some time in the day. As the house stands well back from a country road, there is no occasion to conceal any part of the immediate grounds, as is desirable in town or suburban homes; but whether the family group be gathered in the dining-room, which looks out to the distant western and southern horizon, or on the broad piazza at the close of a summer's day, or, in the chill of autumn, about the fire in the family-room, with its beautiful outlook and its daily flood of sunshine,—whatever the time or season, everything combines to strengthen the family ties, and the passer-by will recognize at a glance in the plain, even severe, simplicity of the house, as it reposes in the well-kept lawn judiciously set with trees and flowers, the home of a family living in consistent harmony with environment.

Perhaps I can better illustrate the central thought which I have endeavored to explain by a home which combines, to some extent, the elements of metropolitan and country life. This is shown in the following plan of the home of a gentleman who, while attending to his business in the city, makes his home at the outskirts of a country village, an hour's ride from town, and who willingly submits to the inconvenience of living at a distance from his business in order to secure the advantages of a real home for his family. The establishment has spacious grounds, and includes a farm also. The arrangement of the grounds may be briefly described as follows, showing their relation to the house itself. The carriage-house with its adjoinings are northwest of the house, and by trees and shrubbery are suitably obscured, while from the street on the east and running northward a beautiful view may be had of the house and so much of the grounds as are intended for the public eye. There is a beautiful lawn to the southward, which includes not only ornamental trees, shrubs, and flowers, but a tennis-court and croquet-grounds as well; and all so well secluded by evergreens and hedges that the visitor gets no glimpse of its charms until he is well within the gate. Yet the contour of the ground is such that, with care in the arrangement of trees and clipping of hedges, the beautiful landscape is not obscured in the view from the house. This home lawn bears much the same relation to the rest of the grounds that the great family-room does to the other rooms.

Returning now to the interior, I will remark in passing that the American parlor has become so firmly established in our homes that its assumed necessity must be conceded to have some foundation in reality. It is not alone in the houses of the rich and well-to-do that this sentiment prevails, but on this point the farm dame in her secluded home and the mechanic's wife agree. At some future day



A SUBURBAN DWELLING, BLENDING TOWN AND COUNTRY LIFE.

a syndicated social clearing-house, with its various branches, may succeed in effecting an exchange of formal visiting cards and save the tiresome waste of present formalities, but, until such time, formal society calls must be made in person and received in a parlor. Moreover, we are not yet so old as to have forgotten how useful a parlor was when one or more members of the family desired to entertain company without the presence of the whole family. Yes, the parlor must be conceded as a necessary part of a complete home, but it must not be permitted to dominate: instead, it must be placed in a subservient and appropriate relationship,— must, in short, be a servant, and not a master, of the family life.

In this house the hall is seen to fill its sphere admirably. It contains no great and ornamental fireplace, no easy lounging-chairs and table of china; in fact, there is an entire absence of those conveniences, so much in vogue at the present time, which tend to convert the hall into a family sitting-room, and thus defeat its best uses. Instead, it is confined to its true utility as an apartment of entrance. But it is spacious, and made very pleasing by the subdued light from the windows on the stairway, which light the upper hall as well: and on social occasions a very pretty effect is gained by throwing the three principal rooms together. There is a lavatory under the stair-landing, opening into dining-room and hall. While the dining-room is commodious and gives a pretty glimpse of the street and village towards the north-east, the great family-room is the recognized center of attraction. The floor is covered with matting not too good for daily use and in no danger of fading by the floods of sunshine admitted through the great south window. In sultry weather the vine-screened piazza has its attractions, but the chill of evening is dissipated by a fire in the open fire-place, and in winter, though the house is heated by a furnace, the open fire, consuming wood cut on the farm, adds a charm which is no less potent now then it was when Ik Marvel sung its praises. Here is the great center-table loaded with the newest books and magazines; the piano and the quiet games of childhood; the work and reading of the older members: in short, here is the life—I use the word in its completest sense—the life of the family; and dull and irresponsive indeed must be the nature of one reared in these influences who could find stronger attractions in the saloons. Adjoining this room is its necessary adjunct, the full usefulness of which is not indicated by its name,—"library." Besides its table and shelves of books, it contains the master's desk, and is, in one of its uses, his home office, its outside door making it convenient for council with the farm forces. It also furnishes a retreat on special occasions for other members of the family. Of the upper floors it is not necessary to speak in detail. The bath- and toilet-rooms are on the second floor, and the rooms of the female servants are on the third floor, while the laundry is in the basement.

In studying this home, it will perhaps assist us to a fuller consideration of the subject if we reflect upon the possibilities of failure presented by these conditions. The architect of city structures who could not free his mind from the habit of thought engendered by the necessity for narrow frontage and close proximity of the street might very easily have erred by giving a narrower frontage and greater depth, and, following the same habit of thought, would have divided the great family-room, and called the front room thus made a "reception room," a sort of lesser companion piece to the parlor, and furnishing one more enclosure from the sunshine.

Nothing would so completely destroy the divine harmonies of home life as a change of that kind, for the apartments of ceremony would thenceforth tyrannize over and dominate the domestic apartments. There being no room for the organic family life to attain its freest development, it would, almost of necessity, become fragmentary. The mother would find a room up stairs for her reading and work, while the boys and girls, feeling, without understanding, the undefined want in their home life, would go forth into the world, as so many have done, without that restraining influence in the character which is seldom acquired outside of home.

It will not be necessary for me to adduce further examples to illustrate the one thought that I have sought to explain in connection with this subject. Whatever in home architecture tends to separate the family into groups must, to that extent, annul family influence, because such influence depends for its best success upon the solidity of the organic home life.

I have not thought it necessary to treat specifically of the exterior, yet the same principles will apply to some extent here also. We have seen that the interior should embody a symmetry in just keeping with the family life ; if this thought is elaborated consistently, the exterior will, almost without effort, give expression to that consistency in an effect both pleasing and restful, and the structure will become a finished section of its surroundings, or an attractive point within it.

The architect who justly respects his profession will approach his work in the reverent spirit of the old masters who held their task so sacred that each part was wrought to its fullest perfection, regardless of whether it was to be seen in the particular niche it was destined to occupy. For who shall say when will cease the influence of those who construct the mould and environments which are to give form and direction to character, sentient or unborn?

JAPAN'S INVASION OF THE COMMERCIAL WORLD.

By Allen Ripley Foote.

JAPAN may become the leading industrial and commercial factor in Asiatic trade. It may be supreme in its own empire. But there are ethnical reasons why it can never be sovereign beyond the zone of its oriental influence.

In basing its campaign for commercial conquests upon its readiness to adopt foreign inventions without giving compensation, and its ability to erect manufacturing establishments in which to employ its cheap labor, Japan exhibits its inferiority. So long as the creature is inferior to its creator, so long will an imitator be inferior to an inventor. By refusing to recognize the right of property in an idea, through declining to protect the rights of inventors to their property, Japan deprives itself of the advantages it might derive from inducing the inventors of the world to assist its development by establishing their undertakings in its empire, and condemns its own workmen to remain imitators by withholding from them the stimulus of reward for acquiring inventive talent. This failure will prevent it from bringing and maintaining its industries abreast with the best developments of the age.

Two incidents may be cited to illustrate these points. It is reported that a representative of the Japanese government came to Chicago to buy several electric-lighting plants for the home palaces. He bought one, and was not heard from again. A Chicago gentleman visited the palaces later, and discovered half a dozen copies of the original plant in use, made by Japanese workmen, even the name-plate having been reproduced. It is also said that a Japanese agent bought a piece of machinery in Chicago, and then stated that he could have it reproduced at home for just one-half its cost in America. These are illustrations of the inherent weakness of the Japanese character. The absence of a delicate sense of honor is shown by the copying of an American manufacturer's name-plate and placing it upon a Japanese imitation of his work. Inability to comprehend the forces that are the true sources of power and greatness is shown by the cunning assumption that want of power to originate a machine can be overcome by ability to copy it. How can imitators hope to keep themselves abreast with a nation of inventors and originators? By the time their inventions are sufficiently developed to be felt in the world's markets, the designs will be out of date. The intelligent will not have them.

Japanese cheap labor is a chimera. Enthusiasts have talked about the possibility of Japan flooding the United States with cheap buttons, bicycles, matches, sashes, doors, blinds, and all kinds of wooden ware, with duty paid, at from thirty to fifty per cent. less than the wholesale prices charged for the same goods by American manufacturers. In considering such statements, it is well to remember that the basis of comparison is false, because such goods as the Japanese would send to America in these lines are not made in the United States. Japanese imitations are inferior goods. Their appearance and cheapness may enable them to find a market in Asia (where the people are not good judges of quality) until orientals get better acquainted with American products, but there is no probability of their obtaining a permanent foothold in Europe or America.

Low rates of wages do not determine low cost of production. Wages are higher in the United States than elsewhere, but American manufacturers can undersell Englishmen in their home market, in many lines, and dispute trade with the poorest-paid labor in the markets of continental Europe. The secret lies in being able, by the aid of ingenious devices and labor-performing machinery, to increase the output enormously per dollar of labor cost. The course of events will show that labor cost will be decreased in America in the future, as it has been in the past, by the use of well-devised labor-performing machines under the management of highly-paid workmen possessing great skill and intelligence, and that it will be increased in Japan as the workmen become more intelligent and conceive higher ideas of living. The Japanese of the next century will have more wants than the Japanese of to-day, and will demand many times the present rates of wages. This movement is already being felt. In the last seven years, according to Japanese official reports, the wages of females employed in cotton spinning have increased thirty-seven per cent.

Under date of January 14, 1896, the late Col. John A. Cockerill wrote to the New York *Herald*:

> For the last four months there has been a steady demand upon the part of salaried men for an increase of pay which would enable them to live comfortably. The government has led off recently by doubling the salaries of all its foreign employees. This has been followed by a number of big corporations. They have yielded to the demands of their people after the usual struggle, and this is the beginning. Wages are everywhere being pushed up, and in all branches where skill is required. Not a business concern in Japan will escape the effect of this curtailment of profit incidental to a fifty per cent. increase in salaries and wages.

This will wipe out the margin by which the Japanese have announced that they will undersell Americans in their home markets. Japanese workmen, in their attempt to compete with American machinery, are destined to meet the same fate now being experienced by

Chinese laundrymen in the towns of western States, where the American steam laundry has driven them entirely out of the business.

An American watch-manufacturing plant is in operation at Osaka under Japanese auspices, but, with the best of machinery, it has not been demonstrated that a good low-priced watch can be made by Japanese labor.

The Japanese bicycle is not neat, comfortable, or durable. It could not be sold in the United States at any price. While this is true of Japan-made bicycles, American-made bicycles find purchasers, among the class of Japanese who are really intelligent, at prices ranging from $100 to $125 in gold.

Japanese matches are inferior. They are mostly hand-made, and cannot compete with the product of American factories where whole pine logs are fed into voracious machines which turn out matches ready for the market.

This failure to judge of quality is causing Japanese manufacturers to dispense with foreign mill managers in the cotton industries and fill their places with natives. The same thing is being done in railroad construction and management. They are assuming capabilities they do not possess.

The following statement was published in "The Japan Weekly Mail," copied from an English journal:

A locomotive was bought in England for £1,550, freight and duty paid (£242) bringing the total cost of the British-made machine to £1,792. That is one story: here is another. A similar locomotive was built in Japan, from English designs and in great part from English material, by native foremen and workmen, its total cost being £1,349, against £1,792 for the engine built in England.

Now, this may be the beginning of considerable change. If, as in the case of the locomotive engine built in Japan, the greater part of the material was imported from England, and then handled by native labor at so great an economy of money, it is possible that this movement may be carried very much further, and it is one to which English workmen should give their attention.

It is said that skilled labor in Japan is paid from 15 to 25 cents per day. In England it is paid not less than $1.50 per day, five hundred per cent. more than in Japan, but the saving here shown is only thirty-three per cent. on the reported cost of the Japan-made engine. If it is estimated that one-half of that cost was paid for labor, the material, in a more or less finished condition, having been bought in England, and if all of the apparent saving be credited to difference in cost of labor, the gain made by employing native labor appears to be sixty-six per cent. on the labor cost. Why was it not great enough to show a saving of five hundred per cent., the reported difference between the rate of wages in Japan and England? It must be inferred that the poorly-paid workingmen of Japan are less efficient than better-paid workmen of England, and for this reason more days' work had to be paid for in Japan than would have been paid for in England. This increase in the number of days' work paid for cuts down the apparent gain from the five hundred per cent. that it should have been on the evidence of the difference in the rate of wages to sixty-six per cent. on the evidence of the pay-roll. Some important lessons may be learned from this fact. The increase in the Japanese rate of wages which is now in process, or an increase in the English output per dollar paid for wages by the use of labor-performing machinery, will quickly overcome all difference in cost, leaving the Japanese no advantage whatever.

It is perfectly safe to make another point. It is not within the range of probability that the Japan-made engine will be as economical in use and service-life as the English-made machine. The difference in economy in use may easily wipe out all of the difference in economy of first cost, so that, as a final result, the Japanese may have saved nothing. A prediction may be ventured. If the Japanese will advertise for bids from the United States for engines guaranteed to perform the same service that is obtained from the Japan-made imitation of the English engine, with as high a rate of economy in service and as long a service life warranted, they will get engines at a price which, combined with economy in service, will leave no profit on Japan made engines at the cost reported for this one. These conditions will hold good for all classes of machinery.

This whole problem was fully comprehended in the reply made by Mr. Charles Cramp, when asked what would be the difference in cost between two steamers exactly alike, one built in an English ship-yard and one in an American? His reply, in effect. was: "There can be no such basis of comparison, as Americans can not build a steamer just like one built in England. If they attempted it, they would, from force of habit, build a better one."

With Japan the reverse is true. There can be no true basis of comparison between the cost of manufacture of American-made goods and Japan-made products, as the latter will not be just like the American products. They will be inferior. This must be so until, through education derived from years of experience, with close observation of machinery, materials, and products, the Japanese become good judges of style, adaptability to purpose, and quality.

Japan may eventually build its own locomotives, ships, railroads, and labor-performing machinery, and take possession of Asiatic markets, but it has not done so yet. By the time its progress in imitative development has brought it abreast with the development of these industries as they exist in the United States in 1896, the progress made by American inventive genius and creative skill will leave the gap between Japanese and American capabilities and achievements in the industrial world nearly as great as it is now.

The Japanese do right in erecting their own cotton mills and steel plants, and in building their own locomotives and ships. It is their duty to do for themselves the best they can, but their industries can have little effect on American home markets or export trade. They may make textiles and take less from Manchester and New England, but to vanquish America they must produce the raw material. They may in time make steel, and become less dependent on America, Germany, and England. They insist that they have all the iron they need, but, as a matter of fact, they have developed no deposits of a high character, though their country may be full of it. Their output in these industries may be greater than the requirements of their domestic trade, and may enter the markets of China and India, furnishing both America and England a new competitor in the orient. Such changes are always going on, but the sovereignty of trade rests with those that possess the widest range of natural resources and the highest degree of inventive genius and productive skill. These are the real factors in commercial competition. America possesses vast natural resources that have not been tapped; in inventive genius and skill it is out-ranked by none; its power of achievement and leadership is assured.

The Japanese are not without evidence of the truth of these statements. American enterprise in Japan is becoming aggressive. The excellence and superiority of American products are gradually making an indelible impress on the Japanese mind, and so winning their way to public favor. Their appreciation of American mining machinery is becoming pronounced; the American locomotive is making an enviable record among them; American machinery for manufacturing silk is doing work which they cannot duplicate in other ways; and numberless mechanical devices are causing them to understand that industrial problems are solved, not by imitation, but by invention.

Looking still deeper into the question, it is seen that Japan is indulging the expectation of being able to sell cotton sheeting and prints in American markets. The cotton it buys in America costs about twenty cents a pound at the door of its factories. It is a long voyage to take cotton from the fields of America to Japan, there manufacture it into sheeting, and then send it back to America for consumption, especially if Japan's merchants make London their entry port to America. This is the false system of economy that England has pursued ever since it became a manufacturing nation and is likely to pursue to its death.

The lack of the power of discrimination and sound judgment is a fatal weakness in an imitator. He copies the faults as well as the excellences of his model. It is evident that Japan is making England its model, and is following it closely. The Japanese appear not to perceive that the economic system which England has pursued, and is pursuing, is to-day its greatest source of weakness. They do not see that England has passed the zenith of its commercial prestige, and is being worsted by one nation or another in every market in the world. They make no account of the fact that the southern States of America have learned the economic lessons taught by unwritten laws, and are building cotton factories amid their cotton fields, where labor-performing machinery, under the supervision of intelligent, free workmen, is bringing the labor cost of products below any point that can be touched by the cheap labor of the Orient.

The Japanese abandon their own export trade to the United States, which is ten times more than it is to England, and attempt to establish their commercial supremacy by trying to compete with England for the carrying-trade of what they buy, as though industrial importance depended upon purchases instead of sales.

Japan is selling ten times as much to the United States as to England, and is buying five times as much from England as from the United States. This fact is indisputable evidence that Japan should develop its merchant marine by establishing lines to the United States, or that the United States should monopolize the carrying-trade of the Pacific by establishing lines of its own in the interest of its exports to the Orient. Since Japan has abandoned the field, it should be at once occupied by America, so that the opportunity will never again come to the dazed imitators of England in commercial invasion.

Modern Japan is making tireless and persistent efforts to free itself from dependence on foreign producers. This ideal partakes of the narrowness of oriental exclusiveness. It is a false guide. It lacks breadth and vital force. It cannot make a nation really great. The effort of every nation should be to produce all things for which the climate, soil, and waters of its country furnish *superior natural resources and advantages*, and to buy from others everything for the production of which they are better provided. This policy will keep a nation in cordial commercial touch with all the world.

Europe may indulge in a scare, induced by Japan's proposal to invade the markets of the world, but America can take no part in it. It is the policy of European countries to seek economic advantages through a meager standard of living that admits of low-priced labor. It is the proud policy of America to seek economic advantages through a standard of living sufficiently high to admit of the fullest development of the energies, skill, and genius of its workmen,—a standard of living that demands the highest wages paid anywhere in the world, but which inspires and satisfies hope, induces inventive genius and creative skill, and equips men *to devise and operate labor-performing machinery* by means of which American products, per dollar of labor cost, are the cheapest in the world.

In the last analysis, the true strength of a nation is in the intelligence of its people. Nature has created no new resources in America since the red race vanished and a white race took possession. It has created no new resources in Japan from the beginning of its traditions until now. The economic differences in these countries, between their present and their past, have been wrought by growing intelligence in the use of natural resources that have always existed, waiting man's ability to utilize them. The greatest economic force is intelligence. Next to it stands natural supplies. These factors create and limit the purchasing power of a people. Following, but of equal importance, are population and extent of territory. The magnitude of these determine the limit of a nation's home market and its ability to resist pressure from foreign trade and to expand its commerce into foreign countries. Where the demand of the home market is sufficiently large to sustain an output great enough to enable producers to profit by all economies and mechanical advantages, and where the largest concentrations of capital, labor, and mechanical power are employed, an industrial momentum is created that may easily overleap the national boundary, and invade the markets of the world.

The extent of a home market is measured with sufficient accuracy by the purchasing power of its people. According to the census reports of the United States, the average yearly income of its wage-earners was: for 1860, $289; for 1870, $302; for 1880, $347; for 1890, $485. Estimating one wage-earner to each five persons, and his income at the average given above, the purchasing power of the wage-earners of the United States was: for 1860, $1,791,800,000; for 1870, $2,295,200,000; for 1880, $3,470,000,000; for 1890, $6,984,000,000.

An idea of the resistless momentum this enormous purchasing power must give to the industries of the United States may be conceived by considering that its increase from 1880 to 1890 was $3,514,000,000, and that the combined imports and exports of the United Kingdom of Great Britain for 1894 were $3,413,300,000,—a sum $100,700,000 less than the increase in wages in the United States from 1880 to 1890, and not equal to one-half of the wage-payments in 1890. The intelligence, natural resources, and purchasing power of the home market of the United States sustain its industries on a scale of operations which enables its manufactures to take full advantage of every known economy, and makes successful competition with them by smaller producers impossible.

Viewed in this light, the low-priced labor of Japan, which has been cited as its greatest competing advantage, is its greatest source of weakness. Such labor cannot be intelligent, skilful, and effective in the highest degree. On the one hand it limits competitive force by degrading quality and quantity of output, and on the other hand it destroys the foundation of industry by reducing the home market to the smallest possible volume. If the report is true that skilled labor in Japan is paid but twenty-five cents a day, and if we generously estimate all labor as "skilled" and earning the daily wage thirty days in every month, the annual income of the wage-earner is shown to be but $90. Taking the population at 42,000,000 and allowing one wage-earner for every five persons, the purchasing power of the wage-earners is $756,000,000,—about ten per cent. of the purchasing power of the wage-earners of the United States. A very respectable power, but not one calculated to cause Americans to be anxious.

This examination of the subject leads to the conclusion that the growth of intelligence in Japan will increase wages, and thus increase its purchasing power, causing the absorption of its industrial energies in supplying its home market, and neutralizing in a marked degree its power to invade the world's markets. If this be true, Japan, instead of becoming an increasing competitor of American manufacturers, will become an increasing purchaser of American products, not only on account of its increased purchasing power, but also on account of the fact that its growing intelligence will cause it to model its economic policy on the lines pursued by the United States, and to better understand and appreciate the advantages it can gain by purchasing as largely as possible from the United States whatever it needs to import.

The volume of Japan's exports to the United States will not increase as rapidly as the volume of its imports from the United States. If this conclusion is correct, Japan is a promising field for American exporters to cultivate.

A PRACTICAL EXPOSITION OF ELECTRIC LIGHTING.

A DISCUSSION OF PROF. CROCKER'S RECENT BOOK.

By Wm. A. Anthony.

FOR a long time there has been wanted a work that should give a comprehensive survey of the whole field that the electrical engineer has to cover when he undertakes the design of an electric-lighting plant, and it is not too much to say that Professor Crocker has succeeded admirably in supplying that want in his work.

What the engineer wants is a plain and concise statement of the results of experience, or of abstruse theoretical investigations which he cannot, for want of time or training, follow out for himself. He is already acquainted with elementary facts and theories, or can find these fully given in numerous existing works. It is well, therefore, that elementary matters are not allowed to lumber up the work. The writer has now in mind works on electric lighting which begin with the attraction of light bodies by amber, and carry the reader through chapter after chapter of the most elementary phenomena to be found described in every college text-book. In the work under review only those elementary facts and principles which have a direct bearing on the subjects under discussion are stated.

The introductory chapter contains a statement of the advantages and disadvantages of the electric light, the cost compared to gas, etc. This is followed by a brief history of its development. I cannot agree with what is said in this chapter in relation to the early views as to the subdivision of the electric light. The subdivision of the electric *current* was perfectly well understood long before the electric light was more than an accessory to lecture demonstrations. Before 1870 the subject was fully discussed in college text-books, and previous to that date I had given questions for examination in college classes requiring the determination of the currents flowing in several conductors in multiple arc. Given a practical incandescent lamp, it was perfectly well understood by those fully acquainted with the science in 1876-7 that such lamps could be run from one source without interfering with each other. But the electric light of that period was the *arc* light. There were practical difficulties in the way of making arc-light regulators that would work successfully from one source, but I do not know that it was ever thought to be theoretically, or even practically, impossible to do this. By the term "subdivision" of the electric light at that period was not meant the supply of several lamps from one source, but literally the subdivision of the *light*. The arc light was a very powerful source of illumination,—far too powerful for use in small areas, indoors. It was desirable to subdivide it into smaller units comparable in illuminating power to single gas jets; but attempts to make small arc lights showed that the smaller light could be obtained only at a proportionally larger expenditure of power.

This was in accordance with the well-known fact that small gas jets give much less light in proportion to the gas consumed than large ones, and led to the statement by some writers that it was theoretically impossible to subdivide the electric *light* and maintain the efficiency of the arc lamp. Whether theoretically impossible or not, this result has never been accomplished.

In the account given of the early Edison apparatus, the author states that the Edison armature did not have more than one-fifth or one-tenth the resistance of previous machines. This is true of some previous machines that were made for a totally different purpose, but machines had been made prior to 1878 having low-resistance armatures. One designed by me and built in 1875 gave two hundred volts with an armature resistance of half an ohm, or one hundred volts with a resistance of one-eighth ohm. In the latter case the machine had a capacity of forty amperes. This machine was described in the *American Journal of Science* in 1876.

In referring to the Brush and to the Weston systems of arc lighting, the author states by implication that the former had, and the latter had not, a satisfactory current-regulator. According to my own observation at that time, exactly the contrary is true. Indeed, I personally knew of Weston arc-light plants in the early eighties in which a regulator *automatically* maintained a constant current when lamps were switched on or off, while he had not known at that time of a Brush plant in which the current was not adjusted by the operator, usually by means of a wooden wedge under the regulator lever. The difficulty with the Weston system was not with the regulator, but with the "short-arc" twenty-ampere lamps, which have never given the same satisfaction as the "long-arc" lamps.

In the chapter relating to general units and measures the author's remarks as to the use of the metrical and English systems are eminently just and timely. We in this country shall undoubtedly for a long time to come use feet and inches in laying out the dimensions of machines, and, this being true, the writer cannot see anything unscientific in the use of the units and coefficients introduced by Kapp for the computation of magnetic circuits. Kapp's system has been ridiculed and maligned, but it seems to me that there is good reason for every unit and coefficient that he proposed; and, having all those at hand, it seems absurd for the American engineer to reduce to centimeters the dimensions of his magnetic circuit, which are given on his drawings in inches, for the sake of using another set of coefficients involving precisely the same difficulties in computation. The table of coefficients for reduction of French to English measures and *vice versa* is more complete than I have seen elsewhere, and will be found extremely useful.

In the chapter upon possible sources of electrical energy the author does well to point out so clearly the theoretical limitations to the efficiency of the steam engine. The second law of thermo-dynamics is so little understood and so generally ignored by practical engineers that its teaching needs to be set before them on every occasion in the most unmistakable language. It is a very common statement—to be found in periodical literature from writers who ought to know better— that the steam engine is a very wasteful machine. One writer said it was a "disgrace to the nineteenth century." The fact is that the steam engine is a very fairly efficient machine. As well say that a water-wheel is a very wasteful machine because of the small power derived, when, from conditions beyond our control, we are unable to use more than a small fraction of the total fall of water. This is exactly the case with the steam engine. Conditions *are* such that we cannot utilize more than a small fraction of the total fall of temperature. Of the available energy supplied to it the engine returns a very creditable fraction.

I am glad to see also the ether and carbon disulphid fallacies pointed out.

With reference to thermo-electric batteries, one great obstacle in the way of high efficiency is the fact that the materials making up the battery are necessarily fair conductors of heat. When, therefore, a high temperature is maintained at one junction of a thermo-electric couple and a low temperature at the other, heat is conducted along the element and must be carried away by cooling arrangements at the cold junction. This heat is entirely wasted, and, in all materials available for thermo-electric pairs, the conducting power is so high that the heat so conducted away is a very large proportion of the total heat consumed.

In the chapter on steam boilers the several types are briefly described. More might have been said of the relative advantages of water-tube as compared with cylinder boilers.

In referring to mechanical stokers, the author states that one objection to their use is "that they feed without regard to the demands upon the boiler." But all mechanical stokers are so arranged that the feed may be adjustable by the attendant, and in some the feed is controlled automatically by the steam pressure.

A very important matter in the economy of large central stations is the handling of the fuel and carrying away of the ashes. Some space might very profitably have been devoted to a description of some of the methods by which this is done, and a discussion of the advantages derived.

Chapter X, in relation to the steam engine, contains much valuable information. The remarks upon fly-wheel construction are especially timely. In view of the disastrous fly-wheel accidents that have occurred in recent years, engineers cannot give too much attention to this subject. The remark has been made that all such accidents have occurred with engines of the Corliss type. These are slow-speed engines, having usually an early point of cut off. They must necessarily have very large and massive fly-wheels. During the early part of the stroke the arms are bent in one direction by the accelerating action of the steam; during the latter part of the stroke they are bent in the opposite direction, from the fact that the momentum of the fly-wheel then carries the load. This alternate tendency to bend back and forth is, to be sure, normal, as the author states, but its effect must be considerable, as is evident from the fact that in all such engines there is a variation of speed during each half-revolution sufficient to produce a marked effect upon the brilliancy of incandescent lamps.

When the fly-wheel of the engine is the driving-wheel, the inertia of the rim carries the load without strain upon the arms during the latter part of the stroke, while during the earlier part of the stroke the arms must sustain the entire strain due to the full action of the steam upon the piston. In case of a sudden increase of load or a short circuit, the strain on the arms would be very little greater, since there is nothing to produce strain upon the arms except the steam pressure and the very small effect due to inertia of the shaft and reciprocating parts when the rim of the fly-wheel is retarded. Now, fly-wheel accidents have been frequent in the case of engines belted from the fly-wheel, where the effect of heavy overloads and short circuits would be a minimum. It seems to me that, since these accidents have been confined to long-stroke, slow-speed, early-cut-off engines, too little allowance has been made, in the design of fly-wheels, for the cumulative effect of these continually-alternating strains.

In discussing the desirability of using condensing engines, the author states that it would probably be easier and cheaper to design the boiler for a higher pressure than to have the complication of a condenser. This may be true, but it must be understood that, with an engine working at one hundred pounds' pressure, to obtain by increasing the boiler pressure the same gain in *efficiency* which could be obtained by adding a condenser, the boiler pressure would need to be increased to two hundred and fifty pounds, which would necessitate building an entirely new engine. That such an increase of pressure is required will appear from the expression for efficiency

$$\frac{T - T_1}{T}$$

For steam at 100 lbs.......................... $T = 338$ Fahr.

In a non-condensing engine.................... $T = 212$

Efficiency .... $= \frac{338 - 212}{338 + 460} = \frac{126}{798} = 15.8\%$

As a condensing engine........................ $T_1 = 162$

Efficiency........... $\frac{338 - 162}{798} = \frac{176}{798} = 22.1\%$

To obtain the same efficiency as a non-condensing engine, we must have

$$\frac{t - 212}{t + 604} = .221$$

$$t = 400^\circ$$

which corresponds to a steam pressure of about two hundred and fifty pounds.

In the discussion of valves and valve-gear a little more might have been said of the advantages of separate exhaust and admission valves. With a single slide-valve, as used in most high-speed engines, a variable compression, as well as a variable cut off, is obtained by the action of the governor under varying load. For the smoothest and best action of the engine the compression should be the same for all loads, and this can best be obtained by using a separate valve actuated by a fixed eccentric for the exhaust. In some of the larger sizes of the Straight Line engine this method is employed.

In Chapter XV are discussed the various methods of coupling dynamos to prime movers. The plan of connecting the dynamo directly to the engine is to be recommended for large machines where the speed of the dynamo is comparable to that of the engine, but I am unable to see the advantage of direct coupling of the smaller sizes,—say, from 75 k. w. down,—except where the space available prohibits the use of belts. A 50-k. w. dynamo may just as well as not run at nine hundred revolutions, while an engine of similar power will run at only three hundred revolutions. For that capacity, therefore, a very much larger and more expensive dynamo must be built for direct coupling than for belting.

The statement on page 242 that rubber belting costs two or three times as much as an equivalent in leather belting must be a mistake, since the first cost of even six-ply rubber belting is much less than that of double leather dynamo belting of the same width.

In Chapter XVI, upon gearing, the author fails to mention one plan of hydraulic gearing that has been proposed, though never to my knowledge tried on a practical scale. It consists of a pump operated from the driving axle and actuating three hydraulic motors on the driven axle. These motors have different capacities, and are so proportioned that, when coupled, all three in multiple, in pairs of two in multiple, and then singly in the order of size, they give seven different speeds, varying by nearly uniform steps. This seems to be a practical arrangement, though perhaps an expensive one, and to involve less mechanical difficulties than a variable stroke pump.

In Chapter XVII the principles and construction of dynamos are discussed. The author does well to point out clearly the fact that there is no royal road to the design of electrical machinery. There is no such thing as framing rules or devising a set of formulæ by which a dynamo for any particular purpose can be designed. A dozen different machines might be built, all of which would serve a required purpose, but which, nevertheless, would differ from each other in form, dimensions, number of poles, speed, etc. ; all might be fair machines, and yet none of them might *best* serve the purpose in view. The development of the best design requires a careful study of the possible forms and dimensions, and finally depends upon an exercise of judgment to be acquired only by experience.

There is probably no branch of engineering in which the problems to be solved involve so many unknown quantities with so few equations to connect them, and which, therefore, require so many arbitrary assumptions in order that the problem may be solved. The design of electrical machinery for any new use should be trusted only to the experienced engineer, and even he would find it necessary to vary his assumptions and make several solutions of the problem before he could be sure that he had hit upon the best design.

Sometimes several considerations are involved in the determination of one or two unknown quantities, different results being arrived at according as one or another condition is made the basis of the solution. Here again the selection of the best value must depend upon an exercise of judgment.

As an illustration, in the drum or Siemens' armature the least resistance would be obtained by making the coils circular, but this would require a spherical armature core, which for many reasons would be undesirable. The next best form would be a core whose length was equal to its diameter, which would require square coils ; but the hysteresis losses in such a case would be greater than in one having the same sectional area, but a diameter less than its length. Again, an armature having a diameter *greater* than its length might be better suited than the other forms to the speed and winding. It is an engineer's province to take all these things into consideration, and endeavor to hit the happy medium best fulfilling all the conditions.

I have not seen elsewhere in so small a space so much general information upon dynamo construction as is contained in this chapter. It is almost wholly a statement of facts and principles without attempt at logical deduction. In one or two cases, where a reason is given, it would have been as well to leave the matter with the mere statement of the fact. For instance, on page 269, under magneto-motive force, the statement is made that, "strictly speaking, the C. G. S. value of M. M. F. is 1.237 times the ampere turns." The author then adds: "This is because the difference of magnetic potential on opposite sides of a turn of wire is equal to 4π times the current flowing in the wire." . . . To one who understands what C. G. S. values and magnetic potentials are the explanation is unnecessary; to one who does not, it is meaningless, as no definition or explanation of these terms had previously been given in the work.

On page 304, near the middle, is a misprint. μ is the quotient of B by H,—not of H by B, as the text has it.

The chapter upon the practical management of dynamos contains many hints, valuable to the dynamo attendant, as to the causes and probable remedies of dynamo troubles. Every dynamo attendant should make himself familiar with the matters treated in this chapter. It must be said, however, that no amount of empirical instruction can serve the purpose of a clear understanding of the scientific principles upon which the operation of the dynamo and the distribution of electrical energy depend, and intelligence in applying this knowledge when occasion arises. I call to mind an instance in which an electrician was sent from a factory a distance of more than a thousand miles to find the trouble in a machine which failed to work; when he reached his destination, he found the difficulty to be a connection so obviously wrong that any one having the least theoretical knowledge or practical experience should have seen and corrected it. All he did was to change the plug of a plug-switch from one hole to another, when the machine started off all right.

In that part of this chapter relating to diseases of dynamos, some of the causes given under some of the headings seem very inadequate. For instance, under the head, "Speed too low," are given "Short circuit in armature," "Armature strikes pole pieces," "Shaft does not revolve freely." If, from either of these causes, power enough were consumed to materially reduce the speed of the armature, effects would be produced that would be far more apparent, and call for more energetic action on the part of the attendant than would reduction of speed. The cause of reduced speed as an apparent "disease" would be looked for in a slack belt, a low steam pressure, or a faulty governor.

The chapters upon the construction and use of accumulators are timely and important. It seems a little strange, in view of the extensive use of accumulators in Europe, that they should have been so little used in this country. The reason seems to have been that in this country capital is worth more, and users of electric plants would not invest the money necessary to instal a first-class accumulator plant. In the attempt to reduce the first cost, plates were made thin and light, and batteries were installed for service which, if any regard were had for a reasonable life, was far beyond their capacities.

There is no question that an accumulator plant may be constructed, installed, and operated under conditions that will bring the deterioration within five per cent. per annum. Such a plant would, no doubt, be a very costly one, but there are conditions under which it might be economy to use it. In a fairly light office-building, for instance, the heavy load will not continue more than three or four hours each day. A battery might take two-fifths of this, reducing the necessary dynamo and engine capacity by this amount, and making it possible to reduce the running time of the dynamo plant and the time of attendance to ten hours per day, during which time the plant could be run at its most economical load. The saving in operating expenses would, in that case, be very considerable, and might more than pay interest on the extra cost of the plant.

As has been already stated, accumulators, as first introduced into this country, were very short lived and very unsatisfactory. It was with such as these that the experiments upon electric traction and train lighting were made, in which, as stated by the author, the life of the batteries sometimes did not exceed one year. The batteries at present furnished by the Electric Storage Battery Co. would certainly give better results than this. It is well that these accumulators are being tested on a large scale, as at the Edison station in Boston and elsewhere.

The remaining chapters of the work relate to switchboards, instruments, and lightning-arresters. Very little is said of switchboards as a whole, that subject being left for further treatment in the second volume. Switches, instruments, and lightning-arresters are, however, briefly described, the conditions of use and the advantages and disadvantages of the different forms being briefly given.

The work is well printed and fully illustrated, and will be found a valuable addition to the library of any one interested in the installation or management of electric-lighting plants.

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Eng. Soc. of the School of Prac. Sci. Toronto.
Eng. Soc. of Western Penn'a. *m.* $7. Pittsburg.
Fire and Water. *w.* $3. New York.
Forester, The. *bi-m.* 50 cts. May's Landing, N.J
Fortnightly Review. *m.* $4.50. London.
Forum, The. *m.* $3. New York.
Foundry, The. *m.* $1. Detroit.
Garden and Forest. *w.* $4 New York.
Gas Engineers' Mag. *m.* 6s. 6*d.* Birmingham.
Gas World, The. *w.* 13s. London.
Gunton's Magazine. *m* $2. New York.
Heating and Ventilation. *m.* $1. New York.
Ill. Carpenter and Builder. *w.* 8s. 8*d.* London.
Improvement Bulletin. *w.* $5. Minneapolis.
India Rubber World. *m.* $3. New York.
Indian and Eastern Engineer. *w.* 20 Rs. Calcutta.
Indian Engineering. *w.* 18 Rs. Calcutta.
Industries and Iron. *w.* £1. London.
Inland Architect. *m.* $5. Chicago.
Inventive Age. *s-m.* $1. Washington.
Iron Age, The. *w.* $4.50. New York.
Iron and Coal Trade Review. *w.* 30s. 4*d.* London
Iron & Steel Trades' Journal. *w.* 25s. London
Iron Trade Review. *w.* $3. Cleveland.
Journal Am. Chemical Soc. *m.* $5. Easton.
Jour. Am. Soc. Naval Engineers. *qr.* $5. Wash.
Journal Assoc. Eng. Society. *m.* $3. St. Louis.
Journal of Electricity, The *m.* $1. San Francisco.
Journal Franklin Institute. *m.* $5. Phila
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q.* $2. New London.
Journal Political Economy. *q.* $3. Chicago.
Journal Royal Inst. of Brit. Arch. *s-q.* 6s. London
Journal of the Society of Arts. *w.* London.
Journal of the Western Society of Engineers. *b-m.* $2. Chicago.
Locomotive Engineering. *m.* $2. New York.
Lord's Magazine. *m.* $1. Boston.
Machinery *m.* $1. New York.
Machinery. *m.* 9s. London.
Manufacturer and Builder. *m.* $1.50. New York.
Manufacturer's Record. *w.* $4. Baltimore.
Marine Engineer. *m.* 7s. 6*d.* London.
Master Steam Fitter. *m.* $1. Chicago.
McClure's Magazine. *m.* $1. New York.
Mechanical World. *w.* 8s. 8*d.* London.
Metal Worker. *w.* $2. New York.
Milling. *m.* $2. Chicago.
Mining. *m* $1. Spokane.
Mining and Sci. Press. *w.* $3. San Francisco.
Mining Industry and Review. *w.* $2. Denver
Mining Journal, The. *w.* £1. 8s. London.
National Builder. *m.* $3. Chicago.
Nature. *w.* $7. London.
New Science Review, The. *qr.* $2. New York.
Nineteenth Century. *m.* $4.50. London
North American Review. *m.* $5. New York.
Paving & Munic. Eng. *m.* $2. Indianapolis.
Physical Review, The. *b-m.* $3. New York.
Plumber and Decorator. *m.* 6s. 6*d.* London.
Popular Science Monthly. *m.* $5. New York.
Power. *m.* $1. New York.
Practical Engineer. *w.* 10s. London.
Proceedings Engineer's Club. *q.* $2. Phila.
Proceedings of Central Railway Club.
Progressive Age. *s-m.* $3. New York.
Progress of the World, The. *m.* $1. N. Y.
Railroad Car Journal. *m.* $1. New York.
Railroad Gazette. *w.* $4.20. New York.
Railway Age. *w.* $4. Chicago.
Railway Master Mechanic *m.* $1. Chicago.
Railway Press, The. *m.* 7s. London.
Railway Review. *w.* $4. Chicago.
Railway World. *m.* 5s. London.
Review of Reviews. *m.* $2.50. New York.
Safety Valve. *m.* $1. New York.
Sanitarian. *m.* $4. Brooklyn.
Sanitary Plumber. *s-m.* $2. New York.
Sanitary Record. *m.* 10s. London.
School of Mines Quarterly. $2. New York.
Science. *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York.
Scientific Am. Supplement. *w.* $5. New York
Scientific Machinist. *s-m.* $1.50. Cleveland, O.
Scientific Quarterly. *q.* $2. Golden, Col
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Journal of Eng. *m.* $2. Ithaca, N. Y.
Southern Architect. *m.* $2. Atlanta.
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago
Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn
Trans. Am. Ins. Electrical Eng. *m.* $5. N Y.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* $10. New York
Transport. *w.* £1. 5s. London.
Western Electrician. *w.* $3. Chicago.
Western Mining World. *w.* $4. Butte, Mon.
Western Railway Club, Pro. Chicago.
Yale Scientific Monthly The. *m.* $2.50 New Haven.

ARCHITECTURE & BUILDING

Design, Construction, Materials, Heating, Ventilation, Plumbing, Gas Fitting, Etc.

The Question of Fire-Proofing.

THE ENGINEERING NEWS for April 9 and 16 contains a valuable paper by Mr. H. B. Seely, entitled "The Art of Fire-Proofing," which reviews the practical results of fire-proofing in steel construction, as shown in fires in large office-buildings, and points out what should be done to improve the efficiency of our building methods in this respect. Mr. Seely does not hesitate to say that much additional experimental knowledge is necessary before the art of fire-proofing can be considered as standing on a firm basis, and he presents a strong plea for further tests and experiments under competent supervision.

Tests for fire-proofing are, of course, exceedingly expensive; yet it is nothing short of astonishing that architects should, year after year, continue to use constructive methods of whose practical utility they know very little, and of whose further development they know nothing at all. A large building is a most costly thing to experiment upon, yet this is just what many architects do with the structures committed to their care when they use methods of construction and of fire-proofing without full experimental demonstration of their value and efficiency.

In commenting on the matter editorially, the *Engineering News*, in a long article which adds nothing at all to the knowledge of the subject, summarizes the dangers from fire as follows: "(1) The most serious danger to the integrity of a building by fire lies in the distortion of the steel frame by heat; (2) the most dangerous defect for a fire-proofing is easy disruption by fire and water, thus leaving the framework practically bare, exposed to the direct action of the flames and affording openings for the spread of the fire; (3) fire records show disruption under fire and water to be the most noticeable defect of the fire-proofing materials commonly used to-day."

In concluding the discussion Mr. Seely says: "Fire-proof construction, as distinguished from incombustible construction, is necessary, if the integrity of a building is to be preserved in very ordinary fires. The usual methods of fire-proofing by the materials of construction are defective from the fact that the protecting value of most materials so used is destroyed by their rupture while heated and subjected to the attack of water. The most promising line of improvement is the use of a covering of material not easily damaged by the combined attack of heat and water, to protect the more sensitive constructive fire-proofing from such attack.

"The facts stand that in every fire of any size recorded in a fire-proof building the building was found vulnerable to the flames; the constructive tiling cracked and broke, the adjacent metal framework was injured, the flames spread by means of doors and stairways and broken tile partitions."

All this is true enough; and it is equally true, as Mr. Seely points out, that our absolute knowledge is not great; nevertheless, everyone must agree that, even with imperfect knowledge and imperfect methods, much has been done to increase the safety of our so-called fire-proof buildings.

Fire-Proof Flooring Experiments.

THE subject of fire-proof flooring is of the first importance in modern building, and it is receiving very careful attention, with reference both to materials and to construction. Since our last number went to press an account of important experiments made by Mr. Howard Constable, at Perth Amboy (*Engineering News*, May 14), and an illustrated paper entitled "Fire-Proof Floors in Modern Buildings," by F. L. Douglas (*The Year Book of the Society of Engineers*, 1896), have been added to the literature of the subject.

Mr. Constable's experiments are described in *Engineering News* by Mr. James

C. Rossi, C. E., who regards the test of a fire-proof floor made at Perth Amboy, N. J., as particularly interesting. The floor tested "was of larger size than usual, and represented an entirely completed floor and ceiling ready for use, with a distributed load of 170 pounds per square foot. It was subjected to a fire of unusual intensity for over two hours, the temperature at the ceiling level reaching over 2,000° by the pyrometer. It also gives some comparative idea of the resistance to fire and water of common plaster, Portland cement, and patent plaster, as well as the transmission of heat through these various materials, and the strength, and fire- and water-resisting qualities, of hard and porous terra cotta arches."

Engravings from photographs presented with Mr. Rossi's communication show that "the terra-cotta arches were uninjured, and merely needed replastering, the common plaster with which they were covered being mostly washed away. When the arch blocks forming the floor were finally removed, they had to be hammered down, and had retained their original strength."

They also indicate that Portland cement stood well, while, under similar conditions, patent plaster was pretty well destroyed by fire and water.

"The test was unusually severe, because the room was piled over 4 feet deep with dry pine and oak. It should be added that the room was fitted with an inlet for air at each lower corner, and an outlet stack at each upper corner. The floors were covered with a grillage of brick, so that the air could get under all parts of the firewood. Iron beams were put in the brickwork of the front and rear 12-inch walls, and were protected in the front wall by 4 inches of common brick and ⅞ inch of plastering, and in the rear wall by 2 inches of porous terra-cotta. None of these beams disrupted the brickwork, nor was their temperature at the center raised to over 160°."

Referring to a system of fire-proofing discussed in *Engineering News*, July 18, 1895, Mr. Rossi thinks that the results of Mr. Constable's tests do not "warrant the unqualified advocacy of plaster nor the sweeping condemnation of terra-cotta arches."

The repairs needed after Mr. Constable's test, as stated by Mr. Rossi, were the smallest possible,—"simply replastering the surface, and consequently much less than having to replace wire lath, etc. The fact that the load has remained on for over two weeks since the fire, and was increased by being soaked while throwing water all over it to cool down the brickwork, is a proof of the great strength of the terra-cotta arches as well as their resistance to fire and water, and their economy in repairs."

Mr. Rossi intimates that the "reasons for some of the failures of terra-cotta arches will be found in poor construction and materials"; that proper design of the hollow tile for arch-blocks is not always secured; and that inferior material and careless laying are also causes of failure.

"It will be found a very difficult matter to prove that burnt clay, when properly treated and applied, is not the best fire-resisting material for building work, and I may say that I believe Mr. Constable has approached this new and half-developed art in the right way by a most extensive and elaborate series of tests of materials, so as to know precisely their intrinsic and comparative merits. A close investigation into the question of usual and unusual temperature will enable one to judge of and compare the various tests that have been and are being made, and to form an opinion upon them.

"The results of transmission of heat through cement, terra-cotta, and brick were interesting, and, I believe, show that some of the results feared by Mr. Seely from expansion are not quite as great as one would infer.

"I would also refer to the point Mr. Constable raised in connection with the Bleecker street fire, which was that a large open space between the ceiling and the floor might be readily converted in many buildings into a reverbatory flue supplying heated air to the room above, thereby intensifying the heat so that no materials could be expected to withstand it. That is a well-known principle in securing intense heat in a furnace."

Some Western Architects.

An extra number of *The Architectural Record* is given up to "A Critique" of the work of notable western architects—Adler & Sullivan, D. H. Burnham & Co., and Henry Ives Cobb,—by Mr. Montgomery Schuyler. It is superbly illustrated with a host of photographs, charmingly printed in the usual style of this periodical; but, notwithstanding the fact that a very large proportion of the work of all these architects, and especially of the two firms, has been great commercial buildings, not a single plan or structural diagram is presented. For a periodical devoted to architecture to thus slight the very basis of the art is quite as sensible as the publishing of a book on anatomy without an illustration of a skeleton!

Than Mr. Schuyler there are few more competent architectural writers in America. He generally has something to say, and says it in a most delightful and readable manner. One may not always agree with him, but his skill of presentation is unquestionably great. If he himself is open to criticism, it is that he suffers somewhat from an imperfect point of view. His study of these western architects is a case in point. In treating of the work of Messrs. Adler & Sullivan, he gives most of his space to a consideration of Mr. Sullivan's extraördinary gifts as an artist. Yet, while this artist's most conspicuous triumphs have been gained in commercial architecture, Mr. Schuyler heaves a sigh of relief when he has passed them and can say a word or two on Mr. Sullivan's smaller buildings. These, by the way, are not so well known as his larger work, and the illustrations of them which accompany this article will be eagerly welcomed by his admirers. If Mr. Schuyler had thoroughly absorbed the spirit that animated his subject in his designs, he would not have hastened from high buildings to low ones, and in this failure to put himself in the architect's place is the writer's chief misfortune.

The author of this monograph is wise not to draw comparisons between the buildings of the different architects he considers. Messrs. Adler, Sullivan, Burnham, and Cobb are indeed representative Chicago architects, but it is impossible to imagine a greater contrast than exists between their work. In Mr. Sullivan, a man of striking originality and power, whose fine artistic perception has been developed to the utmost, we have the artist unmistakably. Mr. Burnham pretends to little of this quality, though the one building with which his name is most intimately associated—the Monadnock—is one of the most successful high buildings in America; of his well-known and thoroughly-proved qualities as administrator it is not necessary to speak, but it is these qualities that have won him the renown he has, and have made him the notable figure he is in Chicago architecture.

It is, perhaps, a significant fact that, notwithstanding the fame of these two firms, the number of their undertakings has been relatively small. Artistically, of course, there can be no comparison between them, for the work of Mr. Burnham makes no pretence to that artistic originality which is so notable in the productions of Mr. Sullivan. But with Mr. Cobb we have an architect of a different sort. Many of his buildings are both original and beautiful, though they do not bear that impress of refined thought which is so characteristic of Mr. Sullivan's. But, unlike either of his brothers, Mr. Cobb's work has been conducted on the largest scale. His buildings are almost as the sand of the sea for number, and not a few of his undertakings, notably the University of Chicago, have been produced, and in a sense completed, within a fraction of the time that might justly have been given to them. It is fortunate that, with this rapid production, there has been a relatively high standard of architectural excellence; his work, without rising to the rank of great, is generally pleasing, and, in some cases, has been decidedly interesting and original. Of the three men Mr. Cobb is perhaps the most typically American in the magnitude and variety of his undertakings, and typically American also in the average quality of his successes. He is typical, moreover, of that spirit for large enterprises which those outside of Chicago consider characteristic of that city. But whether these are the qualities to be considered in architecture those that come after us will be better able to judge.

Radiator and Box-Coil Connections Under the Mills System.

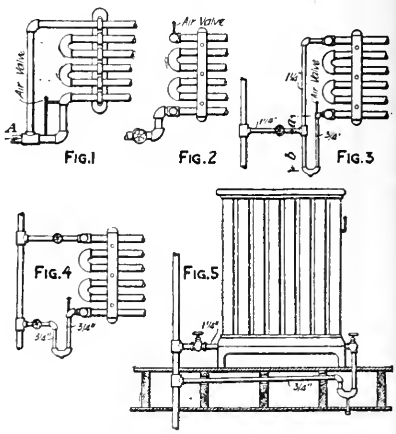
MR. EDGAR KIDWELL writes to *The Engineering Record* (April 25) describing and illustrating a method of making radiator and box-coil connections, which, he says, has been applied in Engineering Hall, at the Michigan Mining School. Referring to a discussion in a previous issue, by Mr. E. E. Magovern, and a statement by the latter of defects in the usual connection (Fig. 1) and in the connection (Fig. 2) recommended by Mr. Magovern, he confirms the defects in the connection shown in Fig. 1, but considers that shown in Fig. 2 as also defective, except when the coils are small and the steam pressure very steady.

"In case of coils containing 60 to 85 square feet of radiating surface, there would be such violent pounding under ordinary fluctuations of steam pressure that these coils had all to be shut off. The two-pipe system could not be permitted, and it was a question of making these coils work on the one-pipe system, or else replacing them with cast-iron radiators.

"Figure 3 shows the result of the experiments made. The writer is familiar with the use of water seals in heating, and has himself often used them, but the precise arrangements here described are new to him, though doubtless known to others. It is evident that the water seal causes the arrangement to work exactly as in a two-pipe system, except that the return water flows from the top along the bottom of the horizontal connecting pipe. The drawing shows sizes of pipe used for coils two to three pipes deep, eight high, and 8 to 11 feet long, all 1¼-inch pipe. A 1½-inch supply would be better, but in this case 1¼ was used, owing to size of outlet in the riser.

"The only precaution to observe in this connection is that the distance *a* must be greater than the head of water equivalent to the maximum drop of pressure between the supply and return pipe of the coil. The writer has found that in all his work a distance of 7½ inches is ample. Distance *b* should be not less than this; in the work under question it was anything from 7½ to 14 inches. Gate valves must be used; globes will not answer. If the fitting is well done, and the supply pipe has a little fall, the radiator will be noiseless under any changes of steam pressure.

"The writer does not like to have steam



RADIATOR AND BOX-COIL CONNECTIONS.

and water going in opposite directions in horizontal pipes, unless they are very short; hence has designed connection as in Fig. 4, to be used when radiator is more than 3 feet from the riser. The dimensions of the trap should, of course, be the same as in Fig. 3. When it is possible to use this design, the writer prefers it to Fig. 3, even when coil is quite near the riser.

"Some object to the one-pipe system because of the pounding when a radiator is turned on, and the boiling or gurgling sound frequently heard when the radiator is in use. The writer has had to consider cases where such troubles existed, and it was decided to apply the principle underlying Figs. 3 and 4. Figure 5 shows the result of the experiments, and it completely cures the evils. Everything works as in a two-pipe system; water and steam go the same way, the circulation is rapid, and the radiator is noiseless.

"A return bend with ¾-inch back outlet was used for bottom of traps, and into outlet was screwed a capped nipple, or a bushing and petcock. These traps have ıever given trouble, except in one case, where the fitter carelessly left in the pipes nough chips to plug up the bend.

"The writer has given the above conıections two years' trial, and found them ıighly satisfactory, if the work is properly lone. The scheme is superior to the two-ɔipe system, in so far as it is impossible to lood the radiator by leaving open the re-.urn valve. If this be done in Figs. 4 and ;, the steam pressure will drive the water n the trap up into the radiator, and make ı very decided noise, before the party who :losed the steam side can get very far ıway, and it thereby gives warning that :he return is open. The writer considers :his a valuable feature, as he has seen numerous cases where, in a two-pipe system, the flooding of radiators and consequent leakage around valve stems and through air valves has seriously damaged furnishings in houses, and books and apparatus in schools.

"In Engineering Hall, Michigan Mining School, cast radiators are used on the second floor, part of them with ordinary one-pipe connections, and part connected as in Fig. 5; on the first floor (shops and lavatories) coils are used, all connected as in Figs. 3 or 4; in the basement (shops) coils with regular two-pipe connections are used. The relative performances of these have been carefully watched, and the connections here described are in this case considered preferable to the others."

The High-Building Bill.

At a recent meeting of the New York chapter of the American Institute of Architects, reported in *Architecture and Building* (May 23), there was a spirited discussion of the act to regulate the height of buildings in the city of New York, introduced in the senate of the State of New York by Senator Pavey. In this discussion many prominent architects took part, the meeting having been specially called to consider the bill.

Probably the remarks of Mr. Post on this occasion voice the feeling of the profession with reference to the extension of tall building better than anything else we can quote from the discussion. This well-known and influential architect remarked:

"I have built many of the high buildings in New York, and have on my table at the present time plans for several proposed new buildings in which my clients demand that they should be, in my opinion, abnormally high. I nevertheless believe it is my duty as a citizen, and as one represented in the advancement of architecture in our country as a fine art and the best interests of the city of New York, to advocate as strongly as possible the passage of a law restricting the height of buildings.

"I believe that it is necessary to the interests of the city, on account of its insular position and great length in proportion to its width, which necessitates to a large extent the concentration of trade, tha ourt buildings should be made taller than would be justified by purely esthetic principles; and therefore, in drawing the act known as the Pavey bill, I so arranged it that the height of the buildings would be about that of our tall structures before the introduction of steel-cage construction. The height of these buildings was limited by the amount of space occupied by the basement piers. With steel-cage construction it is limited by the amount of space which can be devoted to the necessary elevator plant. I have found by experience that one elevator will supply an adequate service for about fifty offices of an average size.

"The objections to very tall buildings are serious. If their construction could be limited to one in each block, occupying we will say one-quarter of its area, they might be considered as a necessary evil, but discriminating legislation in favor of certain pieces of property in the same section would be impossible. It is a fact which is proved by the practice of all our architects that the tendency is to make all new buildings extremely high. This can be stopped now by legislation before the city is irreparably damaged. If it is not stopped, the consequence must be disastrous, and redress will be almost impossible. The results of bacteriological investigation show that the evil microbes flourish and increase in damp, dark places, but that sunlight destroys their life.

"Our narrow streets, when lined with tall structures, will thus become unhealthy alleys, with an inadequate capacity for the passage of the crowds which will flow from these tall buildings, if occupied, for the capacity of the streets is already severely taxed at certain times of the day in the crowded districts by the tenants of the buildings; but, when our streets are so lined, the lower stories of the buildings will be no longer valuable for office or living purposes, and will be only fit for storage.

"The first effect of a law limiting the height of buildings would be doubtless to somewhat decrease the value of a relatively small number of large plats, but in my opinion it would increase the value of small holdings, and the ultimate result would be to increase largely the average value of property throughout the city by preventing the extreme concentration of trade and business in one or two localities.

"From an artistic point of view the gain to the city by the passage of such a law cannot be disputed, for, even if the principal façades of a building towering above the surrounding houses may be handsome, its plain brick masonry on ends and rear will always form a hideous mass. It can only be beautiful if treated as a tower, but such a façade would necessarily entirely lose its effect if connected continuously with another façade of approximately the same height. The filing of plans to enclose the American Surety Company tower on two sides by a building twenty-two stories high forms the best possible illustration of this last statement."

Mr. Constable, while concurring with the views expressed by Mr. Post, added that both the sewer and water-supply systems of the city will soon be overcrowded, if the erection of tall buildings be allowed to proceed without restriction. He fully agreed with the principle of limiting height on the basis of width of streets and graded ratio as proposed by Mr. Post. The bill was approved, with the qualification of some slight criticisms, by all who spoke at the meeting, and a resolution to that effect was passed.

Trade Catalogues.

AMONG the literature of heating and ventilation must be reckoned the trade catalogues issued by the leading houses engaged in this branch of engineering. Some of these contain excellent essays upon the principles of heating and ventilation. The practical experience of their authors gives them a special value, not characteristic of some treatises in which only the scientific side of the subject is dealt with.

This line of thought has been suggested by the careful examination of the catalogues of two prominent firms recently received at this office. One of these presents a line of boilers and heating appliances, for large and small buildings, which can be used either with or without forced circulation of air, and the other deals with appliances for heating and ventilating exclusively by the use of fan-blowers. By carefully perusing, and applying the principles and examples presented in these catalogues, an intelligent young engineer, without experience, but with good native sense and caution, could scarcely go far astray in planning even a somewhat difficult piece of heating and ventilating work.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Architecture and Building and Allied Subjects in the American and English Architectural and Engineering Journals—See Introductory.

*5941. Domestic Architecture in Washington City. Ill. Glenn Brown (Showing a century's architectural development in the nation's capital as expressed in the private residence). Eng Mag-June. 3600 w.

5949. The Dedication of the New Site of Columbia University (A brief account of the dedication, with illustration of the library building, and progress made on other buildings to be erected). Science-May 8. 1100 w.

*5948. The Present Position of Architecture at the Royal Academy. F. Masey (Read before the British Architectural Assn Considering the real nature of the relationship of architects to the Royal Academy: the character of the benefits which they receive; whether there is just cause for dissatisfaction; and if so, what are the remedies Arch, Lond-May 1. 3500 w.

*5985. Stafford County Council Buildings (Descriptive). Brit Arch-May 1. 3000 w.

We supply copies of these articles. See introductory.

6073. The Effect of Fire on Fireproofing Materials. James C. Rossi (Results of a fire and water test made by Howard Constable upon a building at Perth Amboy, N. J. The test is particularly interesting as the floor tested was of a larger size than usual, and represented an entirely completed floor and ceiling ready for use with a distributed load of 170 lbs. per. sq. ft). Eng News-May 14. 800 w.

†6075. Fire-Proof Floors in Modern Buildings. F. L. Douglas (A discussion of fire proof floors. Considers hollow tile arches, concrete iron floors, metropolitan system, Melan system, Roebling system, Columbian system). Engineers' Year Book-Univ of Minn. 4300 w.

*6112. The Stadion at Athens (From a special correspondent to the London *Times*. Historical and descriptive). Arch, Lond-May 8. 1800 w.

†6131. Ninth Annual Exhibition of the Chicago Architectural Club. Peter B. Wight (An account of the exhibition, which is considered the best the club has ever held). In Arch-April. 2000 w.

†6132. A Story of Stone (This is one of a series of articles intended to present many interesting facts regarding stone, reviewed from a scientific standpoint, and with reference to its practical value in construction, etc). In Arch-April. 2000 w.

†6145. The Instruction in Architectural Drawing at Columbia College. William R. Ware (The first part treats mainly of tracing and copying, and is copiously illustrated). Sch of Mines Quar-April. Serial. 1st part. 4500 w.

†6146. The Treatment for Wind Pressure in Mill Construction. James L. Greenleaf (The term mill construction is here used to describe those cases of building in which iron or timber columns support the roof trusses and covering. The paper includes a preliminary discussion of the columns, and truss proper; detailed discussion of the columns and truss proper, with application to a particular example). Sch of Mines Quar-April. 9000 w.

*6173 The Architect's Use of Color. I. Halsey R. Ricardo. II. Christopher Whall (Papers read at the general meeting of the Royal Institute of British Architects, with discussion. The importance of studying materials and their possibilities in producing harmonious effects in architecture). Jour of Roy Inst of Brit Archs-April 23. 14000 w.

6181. The Ancient Cities of Yucatan (Historical and descriptive with illustrations of the peculiar architecture). Sci Am Sup-May 23. 3200 w.

6204 Discussion of the High-Building Bill (General discussion by the New York Chapter A. I. A.). Arch & Build-May 23. 2500 w.

6208. Truth in Architecture. W. E. Doran (Paper read before the Province of Quebec Association of Architects. Historical view revealing the state of civilization, manners, customs, etc., of the people. Also the development of a style that tells of the needs for which the building was intended, etc). Can Arch-May. Serial. 1st part. 2000 w.

*6244. Ribbed Vaults (Tracing the progress of vaulting, with the advantages peculiar to the different kinds, and references to some notable work). Arch, Lond-May 15. 2300 w.

*6255. Our Homes—As They Are and As They Ought to Be. John Balbirnie (Observations on the faults of close-pent houses of towns, with suggestions for improvement). Ill Car & Build-May 15. 2000 w.

*6263. The Resistance of Brickwork. C.H. Blackall (A review of the experiments recently made in England under the direction of the Royal Institute of Architects, with the object of determining the resistance to crushing of brick piers). Brickbuilder-May. 2800 w.

*6264. Mantels. A. Mason (The building of masonry mantels is considered. The necessity of following a drawing exactly and intelligently, etc). Brickbuilder-May. 1700 w.

6317. The New House for the American Society of Civil Engineers (Brief illustrated description). Eng News-May 28. 500 w.

†6366. The Sky Scrapers of Rome. Rololfo Lanciani (Historical account of the causes that led to increasing the height of buildings in Rome and of restrictions recorded, with many interesting facts connected with the height of buildings in ancient cities). N Am Rev-June. 3800 w.

†6371. The Tall Office Building Artistically Considered. Louis H. Sullivan, in *Lippincott's Mag.* for March (A study of the problem, and a support of the three part division as natural and significant). In Arch-May. 3500 w.

†6372. The Fisher Building, Chicago—A Building Without Walls (Illustrated description of this fireproof building). In Arch-May. 4500 w.

6381.—75 cts. The Roman Country House. A. D. F. Hamlin (The first part is a review of the habits of life which made the architecture and landscape of the Roman of more importance than the interiors, with illustrations and interesting information connected with the subject). Arch Rev-Vol. IV. No. II. Serial. 1st part. 2800 w.

6382. The Temple of Iyemitsu. C. T. Mathews (Illustrated description of this temple with remarks on Japanese architecture, and the difficulty of foreigners in understanding the art of this nation, because of a difference in the habit of mind). Am Arch-May 30. 2700 w.

*6383. Opera Houses and Theatres (Review of work by Edwin O. Sachs and Ernest A. E. Woodrow, with illustrations. A work for architects). Arch, Lond-May 22. 2800 w.

*6384. New Municipal Buildings, Croydon (Descriptive). Brit Arch-May 22. 6000 w.

*6403. Architecture in India. Nanaji Narayan Waslekar (The first part is an outline of the several phases of architecture as found in India. Subsequent parts will contain detailed descriptions of some of the principal structures). So Arch-May. 2000 w.

*6405. Masonic Temple, Montgomery, Ala. (Illustrated description). So Arch–May. 800 w.

*6406. The Model School-House. R. L. Jones (Calling attention to the essentials of a model school building and the wisdom of providing the same). So Arch–May. 3000 w.

†6433. South Calcutta Hospital, Bhowanipore (Detailed description of a suburban hospital, with elevation and sections). Ind Engng –May 2. 2000 w.

6446. The Commercial Cable Building (This building is between Broad and New Sts., New York. It was feared that sinking the caissons, to carry the foundations to bed-rock, would weaken adjacent foundations. The method used to reinforce them is described, with description of the foundations themselves, with general plan, elevation, and cross-section ; also details of one of the caissons). R R Gaz–June 5. 1000 w.

6454. Shipping and Transit Needs of New York (Effects of a probable law, limiting the height of buildings in New York city, upon the future needs of transportation to outlying districts is discussed). Arch & Build–June 6. 1100 w.

6465. High-Wind Pressures at St. Louis (Editorial suggestions of availability of effects of the recent tornado in St. Louis, in the determination of wind pressures with reference to the probable results of similar storms upon high buildings and other structures). Eng Rec –June 6. 900 w.

6466. The Tenement-House Competition (The award made by the appointed committee is announced, with statement of conditions, and an abstract from an analysis of the plans as published in the *Tribune*). Eng Rec–June 6. 900 w.

6489. Bruges. George Spencer Morris (Descriptive account claiming the place to be of special interest to artists and architects. Illustrated). Am Arch–June 6. 1300 w.

6490. The Modernizing of Italian Cities. From the *N. Y. Times* (Improvements in the cities of Italy since 1870). Am Arch–June 6. 1300 w.

*6493. Fenestration (Treats of the importance of the design and arrangement of the windows of buildings). Arch, Lond–May 29. 2000 w.

Heating and Ventilation.

5948. Ventilation and Heating—Principles and Applications. A Treatise. B. F. Sturtevant Co., Boston, Mass. (A trade publication containing a valuable essay on heating and ventilating by forced ventilation, or by use of fan blowers for forcing air through pipes or ducts to all parts of buildings. Can be obtained free on application to B. F. Sturtevant Co., Boston, Mass). 169 pages.

6095. Hot-Water Heating and Ventilating of the U. S. Post-Office Building at Lowell, Mass. illustrated detailed description). Eng Rec–May 16. 1400 w.

*6156. Furnace Work (An argument favoring placing registers near inner walls). Dom Engng–May. 800 w.

6168. Heating the Law Courts Branch of Lloyds Bank, Limited, London, England (Illustrated description of building and plant). Heat & Ven–May 15. 1700 w.

6169. Dimensions of Registers and Ventilating Flues. R. C. Carpenter (From "Heating and Ventilating Buildings." Presented largely in tabular form). Heat & Ven–May 15. 1800 w.

6170. Economy of Heating with Exhaust Steam (Presented in form of questions and answers, with tables and formula for computing per cent. of gain or loss). Heat & Ven–May 15. 900 w.

6171. Mill Heating (Facts taken from paper of Geo. W. Weeks, which was read before the New England Cotton Manufacturers' Assn. Illustrated description of a novel arrangement). Heat & Ven–May 15. 2000 w.

6172. Ventilation of Buildings. R. C. Carpenter (Translation from Peclet's Traite de la Chaleur, with notes). Heat & Ven–May 15. Serial. 1st part. 3300 w.

6350. Improving Old Steam Plants (The possibility of large economy, by substituting up-to-date steam plants in old buildings, for those put in at an earlier date is demonstrated by an example and a statement is given of saving in fuel thereby). Mas St Fitter–May. 1300 w.

6469. Heating of the Lord's Court Building (Illustrated description of a system of heating by exhaust steam for a fifteen story building). Eng Rec–June 6. 1200 w.

Landscape Gardening.

6148. The Revised Plan for Jackson Park, Chicago (A reduced sketch of plan prepared by Messrs. Olmsted, Olmsted & Eliot ; also plan for the World's Fair site, which covered the same area. The sketch is explained and the intended treatment described). Gar & For–May 20. 1500 w.

6396. County Parks (Editorial giving reasons why such parks are desirable, as set forth by Prof. T. H. Macbride in a bulletin from the Natural Hist. Laboratories of the State Univ. of Iowa). Gar & For–June 3. 1200 w.

*6404. The Palisades National Park. Waldo G. Morse, in *The Home Magazine*. An entertaining article advancing reasons why the government should own the Palisades and establish a military park). So Arch May. 2700 w.

Plumbing and Gas Fitting.

*6110. Drainage and Sanitary Equipment of the Hotel Cecil (A brief description of the sanitary arrangements in a hotel containing about 1000 rooms, and covering an area of 2¼ acres). Builder–May 9. 1800 w.

*6154. Plumbing Details in Three Large Apartment Buildings (Illustrated detailed description of plumbing above the average for this class of buildings). Dom Engng–May. 2800 w.

Miscellany.

*6155. Early Plumbing in the Metropolis of the Mississippi. T. D. Turner (Interesting reminiscences of western plumbing in the "forties"). Dom Engng–May. 1800 w.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

Foundations for Heavy Buildings.

Mr. Chas. Sooysmith's paper before the American Society of Civil Engineers, reprinted by *The Engineering Record*, is an admirable review of the progress made in this department of engineering work. Nowhere, perhaps, have recent problems been more serious or more imperious in their demand for immediate solution. Mr. Sooysmith says:

"As the thoughtful engineer views the building methods prevailing to-day, it would seem to him that there is perhaps no kind of construction where the force of habit has so disastrously hampered a proper and quick readjustment to new conditions. Buildings of the heights usual until recently seldom put upon the earth supporting them weights greater than three or four tons per square foot, and generally much less than this. The weights were distributed and spread without difficulty by the common methods that had always been used. Of course there was occasionally some particular case sometimes treated in an exceptional manner, but these were never important or numerous enough to bring about any radical change, either in the general carelessness with which the matter of foundations of buildings was considered—or rather not considered—or in the method of constructing them. With the sudden doubling of the usual height of buildings, and the consequent great increase of weight, the old foundation methods became, in many cases, entirely inadequate. If pursued, serious settlement was invited from overloading, and the danger of letting down the underlying material by lateral flow became considerable. In fact, the problem of foundations for a heavy building, where they are not carried to rock or hardpan, has now become (and this fact seems to be strangely overlooked) one very largely of what vent may be given for the underlying material by excavations in the vicinity. It is not sufficient that the weight put upon the soil should not be so great as to cause serious settlement. Under the conditions existing this is not generally difficult, but the material must not be put under a pressure that will cause it to squeeze out from below, in case an opportunity is afforded by deep excavations near by. It will become apparent, ere long, that the erection of heavy buildings resting upon sand or soil which they unduly overload, without carrying their foundations on piles or to solid material, has in many cases worked a serious wrong to owners of the adjoining lots, besides being itself a short-sighted economy, because of trouble and lessened value of the buildings so built.

"Where soils are overloaded, there is extraordinary potency in slight vibration to cause settlement where the conditions are favorable. Hoisting engines are frequently found to be exciting causes in producing unequal settlement in the absence of unequal loading. In one case in lower New York, where a very massive and well-built structure resting upon gravel and sand cracked after it had been in use a considerable time, the only new condition introduced to which it seemed possible to attribute the settlement manifested was pumping clear water from a near-by driven well. It seemed reasonable to assume that the water flowing through the sand made possible a slight readjustment of the particles, which settled into closer union under the vibration of the machinery in the building.

"A most interesting thing often shown by the settlement of buildings is the frequency of movement of the entire mass of soft material in the vicinity of rivers. There is a locality in New York city where there is good reason to believe such a motion to be taking place. For instance, a certain large and well-constructed building resting upon a well-designed pile foundation, and where the piles were driven 40 or 50 feet into the silt, started to settle probably before it was completed; at any rate, it settled from almost nothing at the end farthest from the river to some two feet at the end nearest the river, making a practical wreck of part of the structure. This building was some 200 or 300 feet from the river. An examination of the bulkhead wall showed that the piers had apparently acted as buttresses to hold it back, but that between the piers it was bowed outward. This, in connection with other evidence, seemed to point indisputably to a movement of the entire mass of the adjacent material toward the river."

"The first method that naturally comes to mind for providing a better foundation than can be done by simply spreading the bearings on the earth at customary depths is that of driving piles, and, where there is reasonable certainty that these will always remain wholly submerged, this is generally the best possible foundation, considering its cost, for buildings of considerable, but not of the greatest, weight. The New York building law permits a load of twenty tons per pile, and engineers will consider this, when fair-sized piles are used, to be within good practice; but there are many cases where it is certainly a great mistake to take the aggregate bearing capacity of a pile foundation to be the sum of the safe loads on the individual piles composing it. . . . If the stratum below the piles be at all yielding, it is probably true that the bearing capacity of the foundation is the bearing capacity of the stratum below the piles plus the friction of what might be considered the outer side surface of the entire mass penetrated by the piles."

"A practical difficulty which is apt to hamper the building of a good pile foundation for a building very seriously where there are a great number of piles close together is that, after driving the first few, the material near them becomes so compact that it is exceedingly difficult, and sometimes impracticable, to get the remaining piles down to anything like the contemplated depth. . . . This difficulty is readily overcome where the use of the jet may be resorted to. This is often dangerous in proximity to other buildings, and, it sometimes seriously cracks the adjoining building to drive piles close to it."

"In considering the provision for an adequate foundation for a building, the weight of which seems to demand something better than the old style of simple foundations, the first natural thought is to increase in some way the spread of the foundation so that the unit weight on the material may be kept within allowable limits."

"This has resulted in the so-called raft system of foundations, in which, by alternate layers of steel beams of lessening length, it is practicable to spread the bearing to a sufficient extent. This method requires the minimum depth of excavation, and gives the minimum amount of cellar space. Short of some method of carrying the bearings to a lower and more substantial stratum, as by piles or by excavation to bedrock, this would seem to be the best possible treatment of the problem under such conditions as exist at Chicago.

"In considering the loads to be provided for by the foundations for the Manhattan Life Building, it was found that, if piles were driven over the entire space to be covered by the building, enough piles could not be driven on the lot to sustain the building and load the piles within the limit permitted by the building law. Thus, unless the simple method of spreading the foundations were considered satisfactory, which in this case was out of the question, there was no way but to carry the column loads from the bedrock, which in this case was fifty-four feet below the Broadway street level. The borings taken on the lot indicated the existence of more or less quicksand, and it was feared that any effort to excavate for foundations in the open to the bedrock would result in an inflow of material that would endanger the adjoining buildings. For this and other reasons, the architects, Messrs. Kimball & Thompson, decided upon the use of steel caissons sunk by the pneumatic process, and thus came about the first use of this method.

"Its advantages are: first, the excavation can be carried on under pressure, which holds back from inflow any outside material; second, any obstructions met with in the sinking can be removed without serious difficulty or delay; third, the bottom can be examined, and, where necessary, leveled or stepped; fourth, the work can be executed with speed, because the caissons can be brought on the lot, finished or ready to put together, and, while these are being sunk, the brickwork to form the permanent pier can be built upon them, so that, when the excavation for each foundation is completed, the pier itself is finished.

"The foundations for the new Johnston Building have been successfully put in by means of open wrought-iron cylinders sunk by the water-jet process. This method, while somewhat cheaper than the pneumatic, would seem to be open to the objection that it might not permit in some cases a proper examination and preparation of the bottom and of building the foundation in the dry, and, too, should flowing material under heavy pressure from beneath an adjacent building be encountered, a possibly dangerous vent might be afforded. As yet the pneumatic process is the one safe and sure method for deep excavations, by which all dangers of quicksand or other difficulties can, with certainty, be quickly overcome and a perfect foundation constructed, and this too at a cost, where the conditions are determined, which can generally be estimated with comparative certainty."

The Supporting Power of Piles.

THE RAILWAY REVIEW copies a paper by Franz Krenter, professor of civil engineering in the Royal Technical High School of Munich, read before the Institution of Civil Engineers and devoted to the exposition of a new method for determining the supporting power of piles.

Mr. Krenter calls attention to the frequent impossibility of making this determination by the direct application of a sufficient load, and the resultant practice of attempting to deduce the desired result by the use of rational or empirical formulæ, all of which he considers defective, on account chiefly of the following uncertainties.

"(1) The blow or concussion between the hammer and the pile is usually, for safety, supposed to be inelastic; but this is obviously not the case. The allowance, however, which should be made for the elasticity of the blow is unknown.

"(2) It is not certain whether, as being compressed by the action of the blow, a length equal to the whole actual length of the pile or to some part of it only should be introduced. Redtenbacher in his formula inserts the whole, Rankine only one-half, of the real length of pile.

"(3) The weight of the timber of which the pile consists, and which is introduced into Redtenbacher's formula, varies for pine between 30 pounds and 44 pounds per cubic foot.

"(4) The modulus of elasticity of pine may vary between 1,400,000 pounds and 1,800,000 pounds per square inch.

"These formulas in consequence differ widely in their results. Other formulas in which the compressibility of the timber is neglected are to be condemned as being apt to lead to serious errors in all cases, unless the influence of the elasticity of the timber is inappreciable. This only occurs when a comparatively light pile is driven into soft ground by heavy blows. The empirical formulas are in most cases merely based upon conjecture rather than upon reliable observation, for the reason that the real supporting power of bearing-piles cannot always be tested by the application of a sufficiently large dead load. On the most favorable assumption they will be approximately correct only for cases similar to the one from which they have been deduced, and their generalization will always be open to suspicion. They are, therefore, still less trustworthy than rational formulas.

"The author proposes to show a new method, at once simple and reliable. The supporting power is generally required only when the pile has been already driven into the ground to a considerable depth, and sinks comparatively very little further after a certain number of subsequent blows or sets of blows. It may in that case be concluded that, when the penetration of the pile after a blow has become very small in comparison to the total depth already attained, the increase of supporting power will be also small in comparison with the total supporting power it already possesses.

"Now, let W be the weight of the hammer and h the height from which it falls, then gives—

$$E = W h \ldots\ldots\ldots\ldots\ldots \quad (1)$$

the energy of the blow or set of blows, as the case may be. This energy is spent in producing a number of different effect, which, however, may be summed up in two classes, one of which represents the useful work, whilst the other comprises all that work which is of no use for the particular purpose, and which may therefore be regarded as lost. Let the former be expressed by U and the latter by V; then it is evident that—

$$E = U + V.$$

U only represents the work done in driving the pile against the resistance of the ground through a measurable distance or depth d; and this resistance of the ground to the penetration of the pile is the bearing power of the latter, L; therefore

$$E = Ld + V \ldots\ldots\ldots\ldots \quad (2)$$

The hammer only does useful work from the moment when the pile begins to move or as soon as

$$d > 0.$$

As long as d remains zero, all the work done by the hammer is useless or lost. Let E_0 be the energy necessary to balance the loss V at the limit when the pile will just begin to penetrate further; then

$$V = E_0$$

If now the value E_0 be found beyond which the loss V cannot increase—because for any value of $E > E_0$ the resistance of the ground is overcome and the pile will penetrate, it follows directly from (2) that

$$L = \frac{E - E_0}{d} \ldots\ldots\ldots\ldots \quad (3)$$

It is true that E_0 cannot be determined in a direct manner; but it may be deduced with sufficient accuracy from the result of two subsequent blows or sets of blows in the following manner: Make two consecutive and efficient sets of an equal number of blows, but of different energies, E_1 E_2; that is to say, in using the same hammer apply different heights, h_1, h_2. If the pile still advances considerably, let the blows of the second set be the weaker; if the advance of the pile is small, let the second set of blows be the heavier. Let d_1, d_2 be the depths through which the pile is driven by the action of the energies E_1, E_2, respectively; then, subject to the condition that d_1 as well as d_2 be sufficiently small in comparison with the whole depth already attained, it may be assumed that L as well as V will remain sensibly constant in passing from the first set of blows to the second, so that from (2) it may be deduced

$$\frac{d\,(E)}{d\,(d)} = \text{constant, nearly.}$$

The law according to which E and d vary together may, therefore, in this case, and within the limits in question, be approximately represented by a straight line, inclined toward the rectangular axes of coordinates and intersecting one of them in the point corresponding to

$$d = 0,\ E = E_0;$$

so that

$$\frac{E_1 - E_0}{E_2 - E_0} = \frac{d_1}{d_2},$$

whence

$$E_0 = \frac{E_2 d_1 - E_1 d_2}{d_1 - d_2} \text{ nearly} \ldots \quad (4)$$

"If now in (3) and (4) the number of blows used in the testing set be cancelled, the equations may take the form

$$L = \frac{h - h_0}{D} . W \ldots\ldots \quad (3a)$$

$$h_0 = \frac{h_2 D_1 - h_1 D_2}{D_1 - D_2} \ldots\ldots \quad (4a)$$

where D is the average depth through which the pile is driven by one blow of the respective set of blows.

"Since, for h and D in (3a), h or h_2, and D_1 or D_2 respectively, may be substituted, the bearing power of the pile may be finally expressed

$$L = \frac{h_1 - h_2}{D_1 - D_2} . W \ldots\ldots\ldots \quad (5)$$

"This method is more reliable than any other, dispensing as it does with all uncertain assumption, and being merely founded upon observations in connection with the special case in question.

"Preparatory to ascertaining the supporting power of piles by the method explained, the following precautions are of great importance:

"(1) The piles should rest for some time, in order to allow the stresses produced in the ground by the penetration of the piles to be relieved. It has been stated from experience that piles frequently penetrate with renewed ease after some days' rest. An immediate test-driving might, therefore, lead to erroneous results, and too high an estimate of the supporting power of the piles.

"(2) The heads of the test piles should be sawn off to present a sound and solid surface to the blows of the hammer.

"(3) The number and force of the testing set of blows should be such as not to crush the head of the pile."

The Biscay and Mediterranean Canal.

A RECENT editorial in *The Engineer* (London) says:

"The project of uniting the Bay of Biscay with the Mediterranean by means of a canal capable of accommodating large seagoing vessels has again met with condemnation at the hands of the commission appointed by the French government to investigate the matter. For many years the idea has attracted a good deal of attention, not only from the commercial advantages which would arise from a shortened length of voyage between the ports of northern Europe and the Mediterranean, but also to a large extent from the desire to provide a means of naval communication for the French fleet in time of war, without being compelled to pass under the guns of Gibraltar. In *The Engineer* of November 9, 1894, we gave some particulars of the various schemes which had been proposed for the construction of such a canal, and then expressed the opinion that it seemed to be a waste of time and money to make further investigation into their feasibility. The engineering features present no special difficulty; there is no doubt about the possibility of making such a canal, but it would be at such a cost as to make the investment distinctly unprofitable. The promoters of the present scheme have had the benefit of the fullest publicity and criticism. Premiums amounting to £4,000 were offered for competitive designs, and an exhibition of the various plans was held in Paris in June, 1894. Various ideas of a more or less original nature, including ship railways and rolling docks propelled by electricity, had their respective advocates. The several schemes finally selected indicated a canal of a length varying from 220 to 320 miles, of a size sufficiently large to admit of navigation by the largest armor-plated war ships, and at a cost estimated at £40,000,000 to £60,000,000. After repeated pressure the French government, towards the end of last year, consented to appoint a commission of engineering and commercial experts to inquire into the practicability of the idea, and their report has just been issued. From the financial point of view the commissioners cannot see that there is any probability of a large enough traffic being attracted to the new canal to make it a profitable investment. Then the shortening of the distance between the ports of northern Europe and the Mediterranean would be largely discounted by the slow speed necessitated in navigating a canal where the waterway would be restricted and the locks numerous, so much so that little time would be gained by the new route. Objection is also raised to the danger of floods along certain sections of the canal which it was proposed to construct in raised embankments. The commissioners unanimously condemn the project as one which it is inadvisable to attempt to carry out. After the thorough investigation which the various schemes of the last twenty years have received, it is probable that this is the last that will be heard of the idea for some time to come."

It would be, perhaps, quite natural that a distinctively British journal should not be favorably predisposed toward a scheme which would "provide a means of naval communication for the French fleet in time of war, without being compelled to pass under the guns of Gibraltar," but there need be no suspicion that the condemnatory judgment expressed by *The Engineer* has any national bias. The era when works of this character are constructed for purely military reasons is, happily, passing, and the great thoroughfares and lines of traffic are becoming more and more the instruments of peace than of war.

It is doubtful if any project of this nature and extent could command national support at the present day, unless its economic value were made apparent; in this case the advantages to be gained from the use of the canal seem so small that it appears highly improbable that enough tonnage would seek it to begin to pay any adequate interest on the outlay.

Such schemes, however, have a way of reappearing at periodic intervals, to be re-examined and decided anew in the light of the latest methods and conditions.

Engineering science is rapidly advancing, and the conclusions of the "last twenty years" often have to be considerably modified.

Cost of Excavation on Ship Canals.

IN a communication to *Engineering* (London), Mr. Henry E. P. Cottrell gives some interesting details in the construction of ship canals, which he has condensed into the following table.

TABLE SHOWING THE ACTUAL COST OF EXCAVATION ON SHIP CANALS AND THE PROPORTION IT BEARS TO THAT OF ACCESSORY AND CONTINGENT WORKS.

Name of Canal.	Cost of Excavation per Cubic Yard.	Cost of Excavation per Mile of Canal.	Cost of Excavation per Cent of Total Cost	Nature of Excavation.
	d.	£		
1. Suez Canal	19.30	84,437	37.47	7.2 per cent. of rock.
2. North-East Sea Canal	8.12	57,517	45 11	
3. Manchester Canal	17.66	103,782	30 98	22 per cent. rock, some blasted and dredged.
4. Corinth Canal	20.35	344,254	42.39	10 per cent. rock.

Remarks.— 1. Incidental and extraordinary expenditure was involved through the enforced substitution of costly mechanical appliances and high-priced labor for cheap "fellah" labor when the work was far advanced, and by financial difficulties incident on political complications. The accessory works comprised the forming of a large harbor with two breakwaters at Port Said, and an embankment and breakwater at Suez, the cutting of two canals for the supply of fresh water 97 miles in length, and the laying of duplicate water mains 50 miles in length, etc.

2. Incidental and extraordinary expenditure was involved only in connection with the bogs and quicksands cut through by the canal and a few slips, this being one of the few first-class public works which seems to have been thoroughly thought out and planned in all details previous to commencing the works, and carried out in strict accordance therewith. The accessory works comprised terminal and intermediate locks and sluices, two high-level and long-span railway bridges, the Elder and Büttler Canal works, ferries for intersecting roads, fortifications, land expropriation, etc.

3. Incidental and extraordinary expenditure was involved in the special difficulties occurring in converting a large river subject to high floods into a deep canal for shipping, and continuing this alongside a tidal estuary, and in the alterations consequent on the substitution, when the works were far advanced, of company construction for construction under contract. The accessory works comprised the Manchester Docks, over 100 acres, 15 miles of deviation of railways, with four very high viaducts having openings of large spans, 7 miles of mains for hydraulic installation, numerous ocks, great sluices and swing bridges, and last, though not least, costly expropriations of land and houses and parliamentary expenses.

4. Incidental and extraordinary expenditure was involved in the change of methods in carrying out the work during construction, in stoppage of works for several months, and in the financial difficulties encountered during their prosecution. The accessory works comprised the formation of two terminal harbors, with three breakwaters, the building of two masonry retaining walls along the entire length of the canal from the bottom of the slopes to above water level, and the lining and facing with masonry of weak points in the lofty slopes to protect them from weathering and breaking away; also the diverting of the railway and carrying it across the canal on a high-level long-span bridge.

Proposed Engineering Experiment Stations.

THE Engineers' Club of St. Louis, at their meeting June 3d, received the report from the committee to whom had been submitted for recommendation the bill proposing to make an appropriation for the establishment throughout the United States of "Engineering Experiment Stations."

The conception was no doubt supposed to be similar to that which organized the existing agricultural experiment stations; but the project in this case does not design to wait the slow process of organic growth, but rather to spring suddenly into existence, fully matured and equipped. $10,000 a year is to be immediately set aside for each state and territory, and the sum is to be increased by $1000 annually for the next fifteen years until each state and territory receives $25,000 per annum "for the purpose of providing for engineering experiments" in about fifty different laboratories, "most of which" the committee finds "are now and would remain in relatively incompetent hands."

It is hard to believe that so unnecessary and ill-advised a measure could ever get beyond the lobby. Any supposed analogy to the Agricultural Experiment Stations, is mistakenly conceived. These latter find an excuse for their multiplication in the widely differing conditions of topography, meteorology, soil and climate which make equally varied crop possibilities in closely adjoining sections, and present problems of selection, rotation and culture constantly changing in all the essential factors. Opinions will differ as to the wisdom of the general government taking even such participation as this in economic affairs, but there is at least the excuse of contributing to the enlargement of the total national wealth and production.

Engineering experiment is of a totally different character; the science is exact and the experiments are generally wholly independent of the location of the laboratory itself.

A moderate expenditure in one good laboratory might be a proper and valuable aid for the Government to afford to engineering research, but a very small increase of the amount now appropriated for the Watertown Arsenal would do more good than the $1,250,000 which this proposal would fritter away in fifty duplicate and unnecessary plants.

The entire value of the establishment would seem to be to politicians seeking enlarged "patronage," and it is gratifying to know that the St. Louis Engineers' Club withheld any recommendation of the measure.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

Bridges.

*5974. Opening Bridges. George Wilson (A classification after Rankine of the different ways in which a movable bridge is capable of motion, and a historical account of drawbridges are given in the first part. Also a table of the drawbridges in the United Kingdom, with dates of their erection, rivers, etc., crossed, dimensions, how carried, and methods of moving them is appended). Prac Eng-May 1. 2200 w.

5999. Raising a Highway Bridge (Description of the raising of a viaduct bridge whose pedestals had settled, and query as to the action under load of a clay stratum, overlying soft soils). Ry Rev-May 9. 900 w.

†6081. Strength of Concrete and Steel in Combination. Frank H. Constant (A discussion of this combination which has become quite common in laying the foundations for tall buildings, floors of bridges and buildings, arch bridge constructions of the Monier and Melan systems, etc). Engineers' Year Book-Univ of Minn. 2000 w.

6200. The Bridge Problems of the Greater New York (Editorial presenting the advisability of bridge construction between New York and Brooklyn in order to hasten, with facilities for communication, the real union which is to take effect Jan. 1, 1898). Eng Rec-May 23. 900 w.

6202. Widening a Swiss Arch Bridge (Sidewalks of 5¼ ft. are increased to 10⅓ ft. each, by the addition of a pair of iron corbels or brackets at the top of each pier, which support at their outer ends a longitudinal girder upon which the outer ends of the sidewalk transverse joist are carried. Illustration of structure, elevation, etc). Eng Rec-May 23. 150 w.

*6241. New Cantilever Bridge at Paris (Description of the Pont de Mirabeau, which was opened for traffic on April 20, 1896. It is composed of a river span of 100 m. and two half-spans of 36 m. each). Eng, Lond-May 15. 900 w.

*6254. Some Curious Bridges (An interesting article describing some mediæval bridges of note and of historical interest). Ill Car & Build-May 15. 2800 w.

*6327. Timber Bridge Construction in New South Wales. Percy Allan (Read before the Engng. Soc. of the Royal Soc. of N. S. W. Illustrated description of improved construction). Eng, Lond-May 22. 4500 w.

*6459. Swing Bridges in the Port of Marseilles (A summary of an essay of an Italian government engineer, E. C. Cagli, which is a valuable investigation on the more important of the numerous swing bridges that have been constructed in the port of Marseilles for the accommodation of the road and railway traffic in and about the docks of that city). Engng-May 29. 1200 w.

Canals, Rivers and Harbors.

*5939. The Absence of Facts About the Nicaragua Canal. Charles B. Going (Showing the insufficient investigation and erroneous claims upon the strength of which the United States is asked to risk at least a hundred millions, and nobody knows how much more). Eng Mag–June. 4300 w.

*5944. Bank Revetment on the Mississippi River. Ill. H. St. L. Coppée (A description of the methods adopted for the protection of the Mississippi's banks with a view to continuous deep-water navigation). Eng Mag–June. 4000 w.

*5971. The Nicaragua Canal Estimates (Editorial. Surprise is expressed that a difference of 13 millions sterling more than the estimate of Nicaragua Canal Co. should have been presented in the estimate of the United States government commission, and the editorial is substantially a review of the report of the commission). Engng–May 1. 3000 w.

*6104. The Thames and Severn Canal (Historical description with map of route, connections and illustrations). Eng, Lond–May 8. 1700 w.

6178. The Jetties at Galveston Harbor. Walfred Wilson (Illustrated description). Sci Am–May 23. 1000 w.

*6237. The Manchester Ship Canal, and Canal and River Hydraulics (A discussion of the "omnibus bill" promoted by the Manchester Ship Canal Co.—What ground it covers and the opposition, with reasons). Eng, Lond–May 15. 2800 w.

*6243. The Crinan Ship Canal (A short account of the present canal, with details of a proposed canal along the same route, capable of accommodating vessels drawing 18 ft. of water. Map). Eng, Lond–May 15. 1000 w.

6292.—$1.50. Improving the Entrance to a Bar Harbor by a Single Jetty. T. W. Simons (The writer, convinced that there are places where a single jetty will, if properly placed, accomplish all that could be expected of two jetties, decided that Gray's Harbor in the State of Washington was such a place. The improvement of the harbor was so planned, and a description is presented with facts and reason which led to the adoption). Am Soc of Civ Engs–May. 4800 w.

†6470. Mechanical Methods of Rock Excavation Used on the Chicago Main Drainage Channel. Ill. W. G. Potter (Treating first of the methods of excavation in a few of the recent foreign canals, and of the rock excavation on the Chicago Main Drainage Channel, with particular reference to cost of work. Also abstracts of papers in foreign and American transactions and periodicals, on the status, cost and progress of work on this canal). Jour of W Soc of Engs–April. 14500 w.

Hydraulics.

*6103. Reservoir Dams with Iron Sheeting. Thomas Thomson (An investigation of the points in favor of a dam constructed in this manner. The only disadvantage is fear of corrosion, but with proper precautions the writer thinks it can be so constructed as to last centuries. The cost is only about one-third of that for masonry dam construction). Eng, Lond–May 8. 1800 w.

6288.—$1.50. Flow of Water in Wrought and Cast-Iron Pipes from 28 to 42 ins in Diameter. Isaac W. Smith (Description of the water supply of the city of Portland, Ore., with tests carefully made, and tables). Am Soc of Civ Engs–May. 4600 w.

†6471. Co-efficients in Hydraulic Formulæ, as Determined by Flow Measurements in the Diversion Channel of the Desplaines River for the Sanitary District of Chicago. W. T. Keating, with Discussion (Measurements made according to instructions of T. T. Johnston). Jour of W Soc of Engs–April. 3800 w.

Irrigation.

†6076. Irrigation Engineering in the United States. C. H. Kendall (The importance of the question is shown, and in a general way the paper discusses the present practice and methods employed in the west). Engineers' Year Book–Univ of Minn. 2500 w.

*6235. Our Sub-Arid Belt. E. V. Smalley (An examination of that portion of the prairie land where climate and soil appear inviting to agriculture, but where there is not sufficient rain fall for profitable tillage. The conditions that have proved discouraging are presented, and irrigation by artesian wells, and what it has accomplished is explained. A theory of special methods of soil-culture is being put to practical tests. The writer advocates the scientific study of this region at government expense). Forum–June. 3800 w.

6001. New Method for Determining the Supporting Power of Piles. Franz Kreuter (Read before the foreign Inst. of Civ. Engs. The method is described as consisting in making two consecutive sets of blows with differing energy; and the formulæ deduced from the data are said to be much superior to those generally in use). Ry Rev–May 9. 1000 w.

6022. Effects of Engineering Works on Water Currents. Cyrus Carroll (A study of the effects of piers, wharves, abutments, breakwaters, etc., on the currents, and the damage done by too little attention being given to this subject). Can Eng–May. 2200 w.

†6083. Latitude. William R. Hoag (An article showing how a civil engineer, with his ordinary transit, can easily establish his latitude within 10 seconds and with the aid of a sextant he can determine it within 3 to 5 seconds). Engineers' Year Book–Univ of Minn. 2000 w.

6201. The Simplon Tunnel (A brief account of this tunnel through the Alps, 12½ miles long, to be constructed at a cost of $13,500,000). Eng Rec–May 23 1300 w.

*6246. Tunnelling by Compressed Air. E. W. Moir (Read before the Soc. of Arts. Illustrated review of "shield-driven" tunnels, dating from the time of Brunel. The description of the work done by compressed air is very interesting). Jour of Soc of Arts–May 15. 10500 w.

*6475. Notes on Cement Mortars. Edward Mead (Practical experiences in inspecting and testing cements, and facts which may serve as means of determining reliable materials for cement mortars, thus rendering a more satisfactory grade of work. A large number of tests of cements manufactured in the Louisville district, are given with results). Eng Assn of the South–April. 4800 w.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading, and Domestic Engineering.

Electrical Energy by Direct Conversion.

A LABYRINTH having an infinite number of sealed chambers, each one opening into others, and each containing treasures and hidden keys which unlock hitherto-closed doors of unexplored regions,—such is nature. Every newly-opened door is an assurance that there are other doors to unlock, and that the means of ingress to that which is hidden beyond exists. We shall enter, if we persevere; but the end of the labyrinth will never be reached. The discovery of a Crookes opens the way for a Röntgen, a Tesla, an Edison, a Moore. Chemical discoveries of remote date have given to Dr. William W. Jacques of Newton, Mass., the key to the long-anticipated and much desired solution of the problem of direct generation of electrical energy from carbon.

An account of this discovery is found in an able leading article, by Mr. George Herbert Stockbridge, in the present number of this magazine. Another account is presented in *Western Electrician* (May 23). As this discovery is of a revolutionary character, it is destined to rival Röntgen's discovery in scientific and practical interest.

Although yet in its early infancy, one can foresee far-reaching effects, of which probably those now living will see the accomplishment. Many scientists and engineers have indulged in speculation upon the results that must follow the production of electricity by a much cheaper method than was known prior to Dr. Jacques's discovery. The chemical and mechanical methods hitherto used have been expensive and wasteful; yet, in spite of these drawbacks, the ever-increasing number of the applications of electricity to the wants of mankind is the greatest marvel of our age. If, however, as alleged, it may be reasonably expected that the yield of electricity will be increased by Dr. Jacques's discovery ten-fold, as compared with coal-consumption in the production of electricity by the use of steam boilers, engines, and dynamos,—all of which will be supplanted by the simple apparatus Dr. Jacques employs,—the most unrestrained flight of fancy can hardly cover the extent of the industrial and social revolution that has even now begun.

What room will there be for the steam engine, when the energy for direct driving of electric motors can be obtained at the rate above indicated? And what will become of the legion of gas-motors and oil engines? How will ships be propelled, and passenger trains be drawn across the continents? And what limit can the imagination set to the multiplied field for electro-motors in the shop, the household, the factory, the dairy-house, the forest, and the cultivated field? Verily, if all that is stated about this discovery be true (and all indications point to its truth), we have, at last, directly tapped the great universal reservoir of energy, and may henceforth command a wealth of mechanical power beyond conception.

But, when we have this plenitude of resource, and the need for physical labor has been again reduced to a point far below the present limit of such need, the adjustment of social relations—already a most difficult problem—will press harder than ever upon economists, statesmen, and philanthropists. In view of all these possibilities, now so imminent that they may reasonably be called probabilities, the mind staggers in the attempt at a conception of all the industrial and social changes which will mark the progress of the twentieth century. For, even were we to doubt that the discovery of Dr. Jacques can be made commercially practicable, all signs point to the practicable solution of this problem in some way before long, and wonderful discoveries and advances now follow each other in so rapid succession that scientific men and the engineering world are everywhere holding the attitude of expectancy. So overmastering is the feeling that we are on the eve of great discoveries that many hesitate in developing inventions, through the fear that, in this rapid march, anything they devise will soon be left far behind the procession. Nor is this fear without warrant. The present generation has seen the rise of electric-arc and incandescent lighting, and it is not unlikely that the same generation will see the abandonment of the practical use of these systems in general illumination. The advances made in vacuum-tube lighting by Moore, Tesla, and Edison are portents of the end of existing methods, and promises of a new order of things which not only will include an improved mode of illumination, but will supply the key to other hidden treasures, perhaps never yet dreamed of. Time will show what is yet to be; but, when we reflect on what has been in the short interval of thirty years, and also consider that what has been done supplies the means for yet more rapid advance, we are justified in deeming almost anything within the limits of natural law as not only possible, but probable.

Dynamos for Telegraph Working.

THE names of W. Slingo and A. Brooker are well and widely known as the authors of a valuable treatise entitled "Electrical Engineering." Anything these authors write will be regarded by electrical engineers as worthy of careful consideration. In *The Electrical Review* (London, May 1) they speak of advantages that are possible in many cases through the substitution of dynamos for batteries in telegraph working. An abstract of their joint paper follows:

Except in a comparatively few instances, primary batteries are still employed for working telegraph lines, and, generally, every line or circuit has its separate battery. So far as freedom from break-down or interruption due to a failure of the source of power is concerned, this is, without doubt, the ideal system. The space occupied and the amount of wiring involved are, however, considerable, as may be gathered from the fact that, on a single line worked on the Delany multiplex system, no less than ten separate batteries at each end of the line would be required, having an electromotive force ranging from about eight to, in some cases, two hundred and forty volts. These high pressures are never allowed to get onto the line, for, taking into account the resistance, apparent and real, of the apparatus, etc., the maximum potential difference between the nearest insulator and earth is in no case allowed to exceed one hundred and twenty volts.

It is evident, however, that, when primary batteries are employed, the number of cells required for a large station amounts to many thousands, and the prime cost, cost of maintenance, and space occupied are very great, because the batteries must be arranged so that every cell shall be easily accessible for inspection and renewal, and a considerable number of spare batteries must be kept ready for emergencies, and to replace defective ones while the latter are being examined and brought into good order.

Given two batteries of different types of cell, but of equal internal resistance, electromotive force, and constancy, there is absolutely no difference in the speed or efficiency with which a line can be worked from these batteries, although the contrary opinion frequently obtains. There is one practical objection to the use of a battery of very low internal resistance,—*viz.*, that a heavy current results when the battery is short-circuited, accidentally or otherwise; and the apparatus and battery are then liable to injury. Further, some classes of reversing apparatus have to be so adjusted that the battery is momentarily short-circuited every time the current is reversed, and consequently the battery resistance must in such cases be sufficient to avoid the risk of a too heavy current passing through the apparatus; it should certainly be not less than two ohms per volt. In the event of a very low resistance cell being employed, the resistance may be brought up to this amount by the insertion of an artificial resistance.

The best way of reducing the space occupied by the batteries is to employ a "universal" system of working,—that is, to supply a large number of circuits from one battery. The problem is a very simple one, when the lines offer approximately the same resistance and are worked by single current, as it is necessary only to permanently earth one pole of the battery, and from the other pole run a lead to the key or sending apparatus of each circuit (see Fig. 1). It is necessary to ensure that any one line shall get approximately the same current, no matter whether all or none of the other lines are working,—that is, the point, C, from which

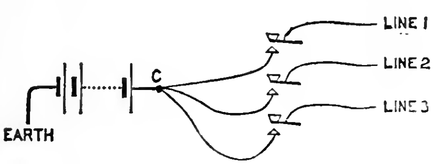


FIG. 1.

the battery leads radiate, must, under all circumstances, be maintained at the same potential. The problem is precisely similar to that met in running a varying number of incandescent lamps in parallel without any perceptible variation in the luminosity of any one lamp; and it will be seen that it is necessary only to make the resistance between the point, C, and the earth, through the battery, *very* low; the arrangement would be perfect,—that is, there would be no variation,—if this part of the circuit could be made so as to offer no resistance at all.

It is, however, an expensive matter to construct and maintain batteries of such dimensions that a number of cells in series shall offer a resistance of less than one ohm. It can be done with secondary batteries, and practically without limit as regards the number of lines operated, but there are objections to this mode of working. Secondary batteries are expensive and require much attention, and a large proportion of the energy spent in charging them is wasted.

A recent installment of dynamos in the Chicago office of the Western Union Telegraph Company replaces no less than sixty thousand primary cells. The most interesting part of the installation is the arrangement of fifteen machines to supply current to the longer and more important lines. These machines are joined in three sets of five each, with their armatures in series, one set being always kept in reserve. The two working sets are used to supply positive and negative currents respectively, the negative terminal of one set and the positive terminal of the other being permanently earthed. These machines develop a potential difference (starting from the earthed end of the set) of 75, 75, 70, 70, and 60 volts respectively, and, consequently, the series may be tapped, either for single or double current working, at five points, the potential of these points being 75, 150, 220, and 350 volts.

In Fig. 2 is shown the various points of different potential connected to the

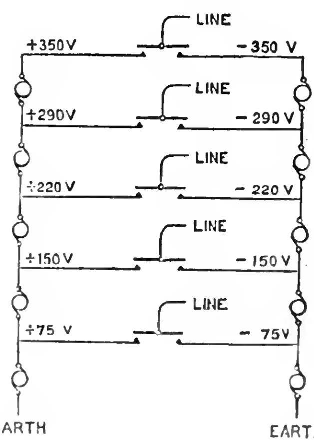


FIG. 2.

positive or negative studs of double-current keys or pole changers, and, of course, any number of connections may be so made, or either of the machines may be tapped at any point for single-current working. It will be observed that in the apparatus used on the longest lines a potential difference of seven hundred volts can be obtained. So high pressures are not employed in England for telegraph work, but we presume that in the Chicago installation each circuit is well protected by fuses and resistance coils, in which case little inconvenience need be experienced, as the reversing keys or pole changers used in the States are actuated by a local circuit, and need not be touched by the operator except for the purpose of adjustment, in which case, we imagine, the battery leads would be temporarily switched off.

In order to facilitate the regulation of the pressure, only one machine in each set is self-exciting; and this supplies current to the other machines in the same set, all the field-magnet coils being arranged in parallel and provided with adjustable resistance coils.

Generally, the installation appears to have been carefully thought out, and, if it does not attain success, it certainly deserves it.

Messrs. Slingo and Brooker point out that an objection to such an installation is the necessity for continually running the whole plant even during those hours when the work is very light; and, with so large a number of machines, not only is the efficiency exceedingly low, but the risk of failure at some point or other must at all times be considerable.

The authors are of the opinion that a much more reliable and flexible system could be obtained by means of motor-generators run from lighting or power mains, which are always available at a large telegraph station, as the risk of failure of supply from such mains is, or should be, exceedingly remote. Such a system would be more efficient, and far cheaper to install and maintain, than either secondary batteries or dynamos used direct; the space occupied would be far less, and motor-generators could be used in much smaller stations than those in which it would pay to install dynamos and engines. A motor-generator, when intelligently used, requires exceedingly little attention, and is more reliable than any engine and dynamo combination; and changes can be effected as easily as with a set of batteries. We look forward with some interest to a trial of these machines for telegraph work.

Artificial Illumination.

In a paper read before the Minnesota chapter of the American Institute of Architects, and printed in *The Improvement Bulletin* (April 17),—the following being an abstract of the paper,—Mr. George D. Shepardson makes some good points. The paper deals chiefly with the advantages of electric lighting as compared with gas lighting, but some principles often ignored by architects in their arrangement of electric lights in buildings merit careful consideration. A distinction is made between the appearance of illumination and actual illumination.

Illumination appearance is obtained by making the sources of light conspicuous. Familiar examples in Minneapolis are the circles of light about the towers of the Glass Block and Olson's, the incandescent crosses on the tower of the Wesley Methodist church, the rows of incandescent lamps along the cornice of the Plymouth, the illuminated signs across Hennepin and Nicollet avenues, the mammoth Ceresota sign above one of the mills, and Olson's illuminated street car.

Illumination without illumination appearance is found in the daylight, where the source of light is rarely looked at directly. Diffused daylight is the ideal toward which artificial illumination should strive. To secure perfect illumination, the source of light should be entirely outside of the range of vision, so that only such light may reach the eye as comes from the illuminated surface or objects. The angle of vision extends from fifty to ninety-five degrees each side of the center line of vision, being measured from the eye as the apex. The source of light should be well outside of this angle, since the eye adapts itself to the strongest light within the field of view. If the source of light is visible, the iris or curtain of the eye closes partially, and so reduces the amount of light reaching the eye from all sources. Hence other objects cannot be seen so clearly, if the principal source of light comes within the field of vision.

For the same reason care should be taken to avoid direct reflection of light to the eye. Hence the familiar rule to have the light come from over one's shoulder. Reflection is less troublesome from large sources of light than from equally strong ones more intense and smaller.

Failure to recognize the difference between illumination and illumination appearance often leads to serious mistakes in lighting public halls. Frequently it is almost impossible to see the speaker on a platform without squinting between or under lights that blind more than illuminate. The drowsiness that forces itself upon an audience is frequently due quite as much to the brilliancy of the lights as to the dulness of the speaker.

For some purposes it is desirable to combine illumination with illumination appearance. Here again the genius of the advertiser finds a fruitful field. Examples in Minneapolis are the rows of arc lights along the sidewalks in front of the Syndicate Block, the Glass Block, and the Plymouth. The arcs call attention from a distance, and also illuminate the store show windows, being high enough not to interfere seriously with the view of those in carriages, and being above and behind persons on the sidewalk. Rows of incandescent lights along the edges of show windows also serve the double purpose. Fancy designs in the windows themselves are effective, if the individual lights are small, or are used with opal or colored globes.

Electric lights can be much better adapted to a combination of illumination with illumination appearance than gas lights. For illumination without illumination appearance, electric lights also render possible new and improved methods. A very satisfactory way of lighting large halls or workshops is by the use of inverted arc lamps hung several feet below the ceiling. The current is sent in the opposite direction from ordinary practice, so that the lower carbon becomes positive and the upper negative. The crater thus formed on the lower carbon sends most of the light upward against a whitened ceiling, whence it is diffused throughout the room, giving a uniform daylight effect. Suitable reflectors hung below the lamps increase the amount of light sent upward, and also render the direct source of light invisible. Daylight effect may also be obtained by the use of incandescent lamps upon the ceiling, screened by semi-circular porcelain shades underneath. Another method is to hide the lamps above a shelving cornice, or behind a translucent cove, so that only diffused light enters the room. Incandescent lamps almost surrounded by opaque screens are very convenient for desks, reading-tables, or sick-chambers.

Economy in Central-Station Lighting Plants.

THE report of the committee on data of the National Electric Lighting Association (*Engineering News*, May 14) is an important document. It is safe to say that it will attract the attention of electrical and mechanical engineers throughout the world. The bulk of the information in this report is presented in tabulated form, and the data are sufficient for determining the question of economy of power generation. The charts of load lines, of which there are three, have been constructed from thirty-minute readings from meters, or estimated from voltage and amperes.

Economies are presented from eighty-two central stations, some of which are the largest in the country, "five of them having an output of over ten million watt hours per day, and forty-five having an output of from one to ten million watt hours per day." The data compiled from eighty-one central stations show an average efficiency of 108 watt hours per pound of coal. One station uses oil-fuel, and produces 1,117 watt hours per gallon of oil consumed. Steam production did not receive the general attention that was paid to other subjects embodied in the circular of inquiry sent out by the committee. Only thirty-one stations reported upon this point. The highest report was 10.5 pounds of steam per pound of semi-bituminous coal burned; the lowest report is 4.66 pounds of water evaporated per pound of bituminous coal; and the general average of the thirty-one reports is 7.09 pounds of water evaporated per pound of coal burned.

One of the triple-expansion engines averages one indicated horse power with eighteen pounds of water. The committee concludes that the question of economy is "as much a question of management and manipulation as of the type of machinery used," and, in the final paragraph of the report, repeats "a former statement that the economy secured in generating power for electrical work does not compare favorably with the production of power for other purposes, and that this is also true after taking into consideration the variation in load due to electrical work. Referring to a recent statement of the economy of the Chestnut Hill Pumping Station at Boston, it was found that, in actual water lifted, a horse power was produced by the consumption of 1.34 pounds of coal; allowing that the efficiency of pumps compares favorably with the efficiency of the generators, and making no allowance for variation in load, one pound of anthracite coal used with the same economy in electrical work should produce 557 watt hours." The load line charts "show a fair average of the variation in electrical work, line three, chart one, dropping from 1,800 k-w at 6 P. M. to 250 at midnight; yet the changes seem, as generally true in electric lighting, to be fairly uniform, and a station planned with the proper units for the work should operate the much larger percentage of its generating appliances on a fair basis of economy, bringing the record in this work much nearer the standards of efficiency in other lines."

Electricity in Dentistry.

HEAT compared with other forces in nature with reference to the ways in which they are useful to man is, like water among substances, seen to be essential not alone to life, but to nearly all the activities of life. It would be difficult to name any article in common use, either in manufactures or domestic occupations, for the production or application of which both water and heat are unnecessary. It now seems that electricity, as a force, is likely soon to rank next to heat in importance to man, if, indeed, it does not already take that rank. In nearly all fields of industry it now holds a useful place, and its usefulness grows with the lapse of time.

In medicine and surgery it has had a place for many years, but in that department of surgery known as dentistry its employment is comparatively recent. It is now, however, found to be applicable to wider uses in this art than was formerly supposed possible, and scientific and electrical journals have discussed its possibilities for dental purposes considerably of late. *Electricity* (April 24) and *The Electrical Review* (May 1) each devote considerable space to this subject. Thus far the operation of small motors used for driving grinding-wheels or disks, drills, etc., has been the chief function which electrical energy has found in the art of dentistry; but the operation of tools used for filling teeth is a recent innovation of great value. The process of filling may by this means be much shortened, thus lessening the discomfort of the patient, and the fatigue,—often a more severe tax upon the dentist than upon the person undergoing the operation.

Electricity describes and illustrates an ingenious, though very simple, electric mallet for the consolidation of gold and other metallic fillings in excavated cavities.

An electric hot-air syringe for drying out cavities, etc., is another ingenious device. In this instrument the air passing through a tube is heated by a small platinum electric coil, instead of a spirit lamp as heretofore.

The same paper also speaks of the use of small electric lamps used in connection with reflectors for examining the teeth and the mouth tissues; but this application is more fully dealt with in *The Electrical Review*, which also notes applications of perhaps still greater importance. In this connection, an address of C. H. Guy delivered at a recent meeting of the Central Dental Association at Newark, N. J., is referred to as broadly stating that, "when anesthetics and other drugs are introduced into tissue and into dentine, their familiar topical effects may be vastly enhanced by the aid of electricity. Broadly speaking, he said any drug that has been used previously without electricity within the mouth to produce a specific effect may now be used with tenfold its former power for good.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Applied Electricity in the American, English and British Colonial Electrical, and Engineering Journals—See Introductory.

Lighting.

†5966. Electrical Engineering in Modern Central Stations. Louis A. Ferguson (A lecture delivered before the students in the College of Mechanics and Engineering, University of Wisconsin. The subject is opened by advice for the choosing of a site, and considers the construction of the buildings, equipment, and all phases of the subject. The Harrison St. Station in Chicago is described, and the value of storage batteries explained). Bul of Univ of Wis-Vol. I, No. 8. 13000 w.

*5979. Electrical Stage Effects. Theodore Waters (An interesting, illustrated account of what has been done in electrical stage work, and how the marvelous effects are produced). Elec Pow-May. 6000 w.

*5981. The Middle Age of Electric Lighting. Ralph W. Pope (Historical account of the early development of the electric lighting industry and of some of the difficulties encountered). Elec Power-May. 3400 w.

*6017. On the Alternate Current Arc (Review of a recent paper by H. Gorges, descriptive of investigations chiefly carried out in Germany). Elec Rev, Lond-May 1. 1300 w.

*6019. The Electric Lighting of the Hotel Cecil (Account of the lighting system which will contain more than 15,000 incandescent lamps, most of which are 16 c. p. Some other facts of interest concerning this large hotel are also given). Elec Eng, Lond-May 1. 2200 w.

6038. Results Accomplished in Distribution of Light and Power by Alternating Currents. W. L. R. Emmet (Read before the National Electric Light Assn. A review of the causes for the slow development of the use of alternate currents, and the means of overcoming the difficulties; facts are given showing the hold already taken upon the industry of the country, and the different methods of distributing power and light by alternating currents are illustrated by diagrams showing the connections used with each). Elec Rev-May 13. 5000 w.

6039. Evolution of Interior Conduits from the Electrical Standpoint. Luther Stieringer (Read before the National Electric Light Assn. An examination of the problem with the object of finding a plan of improvement. A brief review of conduits for water, gas and steam is given, especially before the introduction of electric currents. Facts demonstrated by the best experience of the past 15 years in interior wiring are also given). Elec Rev-May 13. 7500 w.

6040. Some Account of the Evolution of the Inductor Alternator. John F. Kelly (Read before the National Electric Light Assn. The first number contains an illustrated description of the machines of Knight, Wheatstone, Lippens, S. M. Martin and S. A. Varley). Elec Rev -May 13. Serial. 1st part. 700 w.

6071. Comparison of Economy of Various Central Station Lighting Plants (Report of the Committee on Data of the National Electric Light Association. Tabulated statement of watt hours produced per pound of fuel, equipment, efficiency, etc., with diagrams showing variations of load under different capacities). Eng News-May 14. 800 w.

*6128 The Combined Alternate-Current and Continuous-Current System of Supply at Brighton (Illustrated description of the system for supplying the outlying districts during the greater portion of the 24 hours with continuous currents, and during the few hours of heavy load with alternate currents. Particulars showing the substantial gain and practical success). Elect'n-May 8. 1100 w.

6151. The Evolution of the Arc Lamp. L. H. Rogers (Read before the National Electric Light Assn. The development is traced from the beginning and the imperfections and difficulties discussed). Elec Rev-May 20. 5500 w.

6152. Tesla's Important Advances (His remarkable achievements in vacuum tube lighting). Elec Rev-May 20. 500 w.

6158. The Industrial Development of Electric Lighting. George R. Metcalfe (Historical review tracing improvements). Elec-May 20. 3000 w.

6176. Equalizer Systems of Distribution. A. Churchward (Read before the N. E. L. Assn. An abbreviated list of methods that have been devised to accomplish the results obtained by the three-wire system without the use of a divided source of electrical energy, and a compensating conductor connected to the point of division). Elec Wld-May 23. 800 w.

*6210. High-Voltage Lamps, and Their Influence on Central Station Practice G. L. Addenbrooke (Paper read before the Inst. of Elec. Engs The first part considers possible sources of influence on central station practice, life of high-voltage lamps, and the effect of using high-voltage lamps on distribution). Ind & Ir-May 8. Serial. 1st part. 4000 w.

6284. The Energy Required in Moore Vacuum Tube Lighting. Nelson W. Perry (Results of tests made by Mr. Wetzler with description of the method of making these tests, with the aim of obtaining data as to power expenditure). Elec-May 27. 1200 w.

*6326. The Electricity Station at the Earl's Court Exhibition (Details of the electric light installation at the India and Ceylon exhibition at Earl's Court, with report on test of high-speed engine). Eng, Lond-May 22. 4000 w.

6391. Interior Wiring (General consideration of the attributes of a good wiring installation). Am Elect'n-May. 1600 w.

*6395. On the Use and Economies of Rectifiers for Arc Lighting. John Hesketh (Abstract of paper read before the Northern Society of

Elec. Engs. Recent experiences in the use of one special form of apparatus and system of generating the necessary energy. The apparatus is described and the points arising from its use discussed). Elec Eng, Lond-May 22. 2800 w.

6408. A Spectroscopic Examination of Moore's and Edison's Lights. Nelson W. Perry (Examination made by the writer, with remarks and reference to similar spectra observed by scientists). Elec-June 3. 900 w.

6435. Charging for Electric Lighting Service. Arthur J. Farnsworth (The writer states the fundamental principles of a desirable system, notes the defects in the common methods, and calls attention to a system in which some of these defects have been removed). Elec Eng-June 3. 2700 w.

6436. Ferraris and Arno's System of Alternate Current Electric Distribution (A new system of electric distribution of energy with alternate currents, which enables them to supply power, in combination with light, from single-phase alternate current circuits). Elec Eng-June 3. 900 w.

*6448. Islington Electric Light Station (Illustrated description). Eng, Lond-May 29. 5000 w.

*6457. The Electric Lighting of Norwich, Eng. (Description of the work with illustrations of the plant). Engng-May 29. 4000 w.

Power.

*5943. The Electric versus the Hydraulic Elevator. Wm. Baxter, Jr. (Showing the cause that led to the development of the electric elevator, and the advantages that point to its triumph in the struggle for supremacy). Eng Mag-June. 3800 w.

*5961. Electricity as Applied to Dentistry. J. Warren (Brief description of some of the devices by which electricity is made useful in dentistry). Elec, Lond-April 24. 1000 w.

*5984. Storage Batteries. Ill. Charles Blizard (An outline of the applications of batteries abroad and a brief account of the more important applications that have been put down in this country during the past two or three years). Elec Power-May. 5300 w.

*6015. Some Possibilities of Electricity in Dental Surgery (Editorial upon speech made by G. H. Guy at the gathering of the Central Dental Assn., at Newark, N. J., showing that the applications of electricity to dental work are constantly increasing). Elec Rev, Lond-May 1. 800 w.

6021. Dynamo Construction. J. B. Hall (A short description and sketches of a two-light dynamo or one-eighth horse-power motor. Of interest to amateur electricians). Can Eng-May. 1300 w.

†6032. On the Alternating Current Dynamo. W. E. Goldsborough (A study, giving general equations that cover the working of alternating current dynamos, with graphical analysis and discussion). Phys Rev-May-June. 1400 w.

*6035. The Bazacle Electric Power Station at Toulouse (A brief description of station). Elec, Lond-May 1. 1500 w.

6067. Electromotive Force, Counter Electromotive Force and Speed (The terms explained and their relation traced). Am Mach-May 14. 1800 w.

6068. The Electric Motor for Intermittent Work (Explaining the steps by which a motor which at first was entirely inadequate to the work of reversal, was made to do the work with entire success—the expedients adopted having the effect of reducing the current at the peak to a point which the motor could carry without difficulty). Am Mach-May 14. 2200 w.

6080. Notes on the Design and Manufacture of Dynamo Electric Machinery. C. H. Chalmers (Treats briefly of a few points in the design and manufacture of dynamo electric machinery, particular attention being paid to considerations which the technical press and text-books regard as of minor importance). Engineers' Year Book-Univ of Minn. 1200 w.

*6127. Long Distance Transmission of Electric Power. T. A. W. Shock (Read before the Street Railway Assn. of California. Brief description of the Folsom works). St Ry Rev-May 15. 1100 w.

6164. Electrical Tests of Power Required by Machines for Working Structural Steel, at the Pencoyd Iron Works (Tests of machines operated by individual motors, and of machines operated by motor and line shaft). Am Mach-May 21. 1200 w.

6165. Counter Electromotive Force, Torque, Current and Field Strength (The relations between electromotive force, counter-electromotive force and the strength of the field magnets are discussed). Am Mach-May 21. 1300 w.

6276. The Electric Motor in Rolling-Mills and Steel Works (A brief description of rolling-mill work, showing the necessity of having power of some sort available almost everywhere, followed by a review of the wide range of application which electric power has already found). Am Mach-May 28. 1800 w.

*6293. The Economical Generation of Power in Central Stations. C. J. Field (Abstract of a lecture delivered at Sibley College. The writer reviews the changes that have been brought about in the design and construction of stations for the development of electric light and power, and the systems and practices that have brought the best results). Sib Jour of Engng-May. 2700 w.

6298. A New Method for Testing Lubricants. Paul MacGahan (Description of a method by means of which original and useful results were obtained during the course of an investigation made in the mechanical laboratory of Columbia University on the various lubricants used for electrical machinery). Elec Wld-May 30. 900 w.

6304. The Reconstruction of the Plant of the Chicago Board of Trade. Bion J. Arnold (Abstract from a paper presented at meeting of Amer. Inst. of Elec. Engs. Illustrated description). Elec Eng-May 27. 2000 w.

6305. The Hayden Century Clock. M. H. Lockwood (Illustrated description of a novel clock and its workings. The clock is run entirely by electro magnets which are actuated by the current from an earth battery). Elec Eng—May 27. 600 w.

†6307. Electric Elevators, with Detailed Description of Special Types. Frank J. Sprague (An interesting paper, with lengthy discussion). Trans Am Inst of Elec Engs—Jan. 29500 w.

6373. Some Problems in Electric Elevator Work. Ill. H. Cochrane (Read before the Chicago Elec. Assn. A review of some of the details of practical construction, showing that the application of electricity to elevator service involves a great many engineering problems). W Elec—May 30. 5300 w.

*6377. A Producer-Gas-Engine Electrical Plant. Albion T. Snell (Description of the power station, gas engine, dynamo, motors, method of distribution and working of the electrical plant of Messrs. R. Maclaren's iron foundry in Glasgow). Elect'n—May 22. 1700 w.

6392. Repair of Electric Railway Apparatus. W. E. Shepard (A description of the General Electric Controller and the repairs). Am Elect'n—May 2. 200 w.

6393. Faults in Dynamos (A few simple methods of attaining certain ends). Am Elect'n—May. 1700 w.

6398. Storage Battery Manipulation on Variable Loads. J. E. Woodbridge (A consideration of the seeming desirability of the storage battery in the trolley line power station, and the difficulties of operation). Elec Wld—June 6. 1000 w.

6399 Regulation of Rotary Current Motors. H. Behn-Eschenburg (Formulas for this regulating, with reasons). Elec Wld—June 6. 1200 w.

6421. The Action of the Series Motor and Generator (The machine is first considered as a motor, and the action of the current explained, followed by a brief explanation of the action of the series machine as a dynamo). Am Mach—June 4. 2200 w.

6443. Electric Elevators in an Elevated Railway Station (Illustrated description of the western terminal station of the Lake St. Elevated Railroad Company of Chicago. Highly appreciated by patrons, but expense prohibits their extension). W Elec—June 6. 600 w.

*6486. The Maximum Efficiency of Transformers Bernard P. Scattergood (Formulæ are deduced which it is said may be safely used to determine the conditions of maximum efficiency). Elect'n—May 29. 1000 w.

*6488. The Utilization of Water-Power, Especially with a Small Fall, with Some Examples of Plants for the Generation of Electrical Energy. Alph. Steiger (Read before the Inst of Elec. Engs. Showing that the water-powers if judiciously utilized are capable of rendering great service). Elect'n—May 29. Serial. 1st part. 1700 w.

Telephony and Telegraphy.

5960. C. P. R. Telegraph Storage Battery Plant at Ottawa. W. J. Camp (Illustrated description). Can Elec News—May. 1500 w.

*6016. Dynamos for Telegraph Working. W. Slingo and A. Brooker (A suggestion for economizing space. In the Chicago office of the Western Union Telegraph Co., an installation of dynamos has recently been put in to replace 60,000 primary cells, with every indication of success). Elec Rev, Lond—May 1. 2400 w.

*6020. On Railway Telegraphs with Special Reference to Recent Improvements. W. Langdon (Read before the British Inst. of Elec. Engs. The advances are to be found more in minor details than in any radical change. The subject is treated in detail). Elec Eng, Lond—May 1. Serial. 1st part. 2500 w.

6174. Remarkable Feat in Telegraphy (An account of the feat at the N. E. L. A. Exposition, whereby special dispatches over telegraphic circuits, arranged as nearly as possible around the earth, and their receipt at the same place was accomplished within an hour). Elec Wld—May 23. 1800 w.

*6375. Cable Laying in the Amazon River. Alexander Siemens (Abstract of a lecture delivered before the Royal Inst. of Gt. Britain. An interesting account of the experiences and adventures during the voyage of the cable-ship "Faraday" up the Amazon River, last Jan. and Feb). Elec Rev, Lond—May 22. 3500 w.

*6376. The International Telegraph Conference of 1896 (Translation of a circular, written in the French language, and signed "F. Gd." On the necessity of unification of international telegraph rates, with the obstacles. The movements already made to attain this end are reviewed, and a plan suggested). Elec Rev, Lond—May 22. 2000 w.

6496. The Drawbaugh Telephone Case (The Senate Patent Committee favors authorizing the Commissioner of Patents to issue patents to Daniel Drawbaugh. With editorial). Elec Rev—June 10. 1700 w.

†6498. Our Telegraphic Isolation. Percy A. Hurd (The need of a system of telegraphic communication completely under British control. South Africa, India, Australasia and the West Indies are considered and a solution of the difficulty presented). Contemporary Rev—June. 3200 w.

Miscellany.

*5940. Relations of Electrical and Mechanical Engineering. Elias E. Ries (An analysis of electrical engineering, showing the close connection with mechanical engineering of that branch which deals with the design and construction of electro mechanical apparatus). Eng Mag—June. 4300 w.

*5980. The Relation of the Underwriter to the Electrical Engineer. William Brophy (An account of the influence upon the electric lighting industry of the fire underwriters and rules promulgated and enforced by them. The character and efficiency of inspectors is somewhat reviewed, and the opinion is given that the system of electric inspection is of mutual benefit when conducted by men of ability and integrity). Elec Power—May. 3500 w.

*5982. Some Interesting Features (Interesting information in connection with the history of Electrical Engineering, mostly of a personal character. Photographs and fac-simile letters of prominent electricians). Elec Power–May. 800 w.

*5983. Systems of Units. William Hallock (Abstract of lecture before the Henry Electric Club. A brief reference to the earliest use of units of measure and how they were established, and the system adopted by the French and called the metric system ; also the relation of electrical units to mechanical units is discussed). Elec Pow–May. 2500 w.

†6084 Ground Detection in Electric Circuits. H. M. Wheeler (Brief review of various methods with diagrams). Engineers' Year Book–Univ of Minn. 2000 w.

*6129. Prof. Ewing's Permeability Bridge (A magnetic invention for measuring permeability. The principle of action is to compare the sample to be tested, step by step with a standard bar, the B-H curve of which has been previously determined once for all). Elect'n–May 8. 1100 w.

*6130. Some Electric Supply Data (Diagrams showing percentage loss of energy in distribution in some electric supply systems, percentage load factors, percentage maximum demand factors, and tables showing the distribution efficiency, load factors and maximum demand factors, and a comparison with generating expenses and costs). Elect'n–May 8. 800 w.

6205. Direct Conversion of Carbon into Electrical Energy (Illustrated description of the patent of William W. Jacques). W Elec–May 23. 1400 w.

*6247. Experimental Tests on the Influence of the Shape of the Applied Potential Difference Wave on the Iron Losses of Transformers. Stanley Beeton, C. Percy Taylor, and J. Mark Barr (Read before the Inst. of Elec. Engs. An account of some fairly complete experiments on this subject, which were carried out at the Central Technical College, about one year ago. Work of previous investigators is reviewed, apparatus described, etc., in part first). Elect'n–May 15. Serial. 1st part. 3000 w.

6285. An Analysis of Transformer Curves. Charles K. Huguet (Paper presented at the 13th general meeting of the Amer. Inst. of Elec. Engs. Experiments conducted by the writer at Tulane University to investigate a question, which had been subject to an apparent conflict of opinion, by analyzing the current curve into its various components). Elec–May 27. 1600 w.

6286. Electrolysis. William Brophy (Topic discussed before the National Electric Light Assn. A review of the causes that led to placing wires under ground and the difficulties met with. The causes of electrolysis and the remedy). Elec Rev–May 27. 3500 w.

6301. The Paris Electrical Exposition of 1881. William J. Hammer (The important exhibits are recalled and the effect produced on all branches of electrical development). Elec Wld–May 30. 1500 w.

6302. The Crystal Palace Electrical Exposition of 1881-82 (A brief account, especially noting the more complete representation made by the English). Elec Wld–May 30. 500 w.

6303. Effect of Temperature on Insulating Materials. George F. Sever, A. Monell and C. L. Perry (Conclusions drawn from 102 tests on samples of materials, which were furnished by several of the most prominent manufacturers of electrical machinery). Elec Wld–May 30. 3800 w.

*6345. Practical Notes on Underground Electrical Service. E. J. Spencer (A review of the history of underground wiring, its failures and final success. The systems in use for underground wiring are explained, and matter of interest regarding cost, etc., is given). Jour of Assn of Engng Socs–June. 5000 w.

6394. A Biographical History of Electricity (Introductory remarks, and biographical history of William Gilbert, of Colchester, are given in part first). Am Elect'n–May. Serial. 1st part. 1700 w.

6397. An Electromagnetic Theory of the Inertia of Matter. Edwin J. Houston and A. E. Kennelly (The ideas presented are novel and the article is interesting). Elec Wld–June 6. 2000 w.

6407. Dr. W. W. Jacques' Carbon Electrical Generator (Editorial comment drawing the conclusions that (1) the air blast must consume a very large proportion of the total energy of each cell. (2) That in addition to a very expensive form of fuel there must be added the cost of fuel required to keep the electrolyte fluid under very trying conditions. (3) That the electrolyte must be replenished as in other batteries). Elec–June 3. 900 w.

†6426. Mechanical Conceptions of Electrical Phenomena. A. E. Dolbear (The first part traces the progress of mechanical knowledge from the time of Newton). Jour Fr Inst–June. Serial. 1st part. 4500 w.

†6427. Inherent Defects in Fuse Metals Experimentally Considered. Walter E. Harrington (Considers in detail, and demonstrates by tests, some of the defects in fuse metals which condemn them as a safe and reliable means for protecting electric circuits from unusual and abnormal conditions). Jour Fr Inst–June. 3000 w.

6437. The Edison Fluoroscope Exhibit (A description of this exhibit at the Electrical Exposition in New York). Elec Eng–June 3. 1300 w.

*6463. The Magnetic Properties of Iron and Steel (Brief abstracts of two papers by J. A. Ewing and H. F. Parshall. Read before the Inst. of Civ. Engs. The practical importance in relation to the manufacture of dynamos and transformers is referred to, and a permeability tester is described). Engng–May 29. 1000 w.

6484. The Inventions of Nikola Tesla. From the *N. Y. Sun* (A brief review of what he has accomplished). Prog of the Wld–June. 1100 w.

6497. Electrical Features of the New National Library at Washington, D. C. George H. Draper (Description of the electrical installation, together with some observations on the boiler plant and other apparatus in the building). Elec Rev–June 10. 1600 w.

INDUSTRIAL SOCIOLOGY

Recent Legislation in Restraint of Trade.

THE inherent weakness and inutility of existing and recent statutes in restraint of trade are pointed out by Charles F. Beach, Jr., in *The American Journal of Sociology* for May. The author also shows that legal precedents bearing upon what jurists style public policy are fallacious, because, as civilization advances, public policy changes as social conditions change. What might have been good public policy in the reign of Henry VIII is likely to be the very reverse in the United States at the end of the nineteenth century.

The position is taken that, "for all practical purposes, whether those of the student, the legislator, or lawyer, restraint of trade and prevention of competition in trade are substantially equivalent, and are governed by the same principles." In this proposition the word "trade" is taken in its broadest sense, as including "not only the dealing of merchants, but the business of railroading, insurance, and manufacture, and the greater part of all contractual relations between man and man in a civilized community." Legislation affecting these relations will therefore "include statutes regulating the practice of medicine and of law; statutes of patent and copyright; usury laws; Sunday laws; laws regulating the sale of intoxicating liquors at retail; laws regulating the operation of mines; laws against champerty and maintenance; taxation of commerce, and particularly, in this country, of interstate commerce; 'drummers'' taxes; laws attempting to regulate dealings in futures, forbidding wager policies on human life, prohibiting the operation of lotteries, and all that large body of legislation by which the regulation of labor is attempted."

A famous English judge is quoted as saying that "public policy does not admit of definition, and is not easily explained." A decision in an English case is cited as saying of public policy that it "is a very unruly horse, and, when once you get astride of it, you never know where it will carry you." In a recent English case it was also said that "public policy is a variable quantity; that it must vary and does vary with the habits, capacities, and opportunities of the public." Many more quotations to the same effect lead up to the expression of a belief that no fixed rule of public policy can be established.

"Conceding, or, better, realizing, this inherently fluctuating character or quality of public policy, we see that the enactment of statutes to declare or define it must of necessity be a dangerous business, because such statutes, however accurately they reflect the public policy of the moment of their enactment, must almost immediately begin to be wrong. The common law, reposing, according to the legal fiction, in the bosom of the court, is flexible, and can change or be changed, as we have seen, with the change of condition; but a statute stands rigid on the statute-book, and is the same thing yesterday, to-day, and forever; so that it must be amended, or repealed, or modified, or disregarded in the progress of time, as conditions change, in order not to be quite out of tune and touch with the orderly progression of things. This is something which the rural legislator, in his zeal to pass laws upon the subject of trade, seems entirely to have overlooked. Accordingly this inexorable fact has been the undoing of his work. By reference to the law books, he is informed with sweeping generality that, at common law, monopolies are illegal and void. If he be industrious and curious, and reads Norman French, he finds out that, as early as the reign of Henry V, in the year 1415, a case, which seems to have been the first case of the sort, arose, in which a dyer had bound himself not to exercise his trade for half a year in the same town with the plaintiff. In an action on the bond, this was held to be an unlawful agreement, as in restraint of trade. This case was decided long before there was any statute on the subject, and from it has come down to us, in ordinary generation, a long line of decisions upon the general question there involved."

Patents and grants, in the nature of monopolies, followed later, the practice dating from about the time of Henry VIII. In the reign of Elizabeth monopolies were declared illegal at common law. This declaration, often quoted within a recent period, is held by Mr. Beach to have no present force.

"In a legal sense, monopoly, at the present day, simply means the obtaining, without a grant from the sovereign, of the exclusive power to carry on a certain trade or business. In a proper sense, the term monopoly is applied to every large and successful business enterprise; and some statutes, as, for example, the proposed legislation in Illinois against department stores, go so far as to seem to proceed upon the notion that, because an enterprise has attained large proportions, it is, in a legal sense, a monopoly,—*ergo*, unlawful. Railways, national banks, and corporations of all kinds are, in the view of that part of the public in sympathy with such legislation as this, obnoxious as monopolies."

Of the dread of monopoly Mr. Beach says: "Englishmen—and by Englishmen we must include ourselves as of the Anglo-Saxon stock—have always had what they have hugged to their hearts as a 'wholesome dread of monopoly.' No Englishmen ever knew, and no one of us can ever know, exactly what 'monopoly' in this precious phrase means; but that it means something to be dreaded no really sound Englishmen ever doubted. It is a sort of bogey that has served to scare a hundred generations of us. So also, as of course, very much of the recent agitation which has arisen over monopoly, and which has provoked for the past six or eight years a flood of legislation and litigation in the United States in restraint of trade, is the outcropping of the grudge which the 'have nots' always have against the 'haves.' It gave the politicians a chance, of which they were not slow to avail themselves, and of which they have made the most. It is a significant fact that during the same period of time when our legislatures, including the federal congress, have been going off upon a quasi-medieval tangent, the courts have for the most part been unswerved, and have in no notable instance been carried off their feet by the popular clamor. A great number of suits have been brought, in which it has been sought to commit the courts to the same radical views upon the subject which have been enacted into statutes, and in which it has been sought to secure adjudications upon the economic questions involved—for the most part without success. And it is, I repeat, creditable to the courts that this is so."

It is alleged that "the courts, in a great number of cases, have reflected more accurately than the statutes the public policy of the times." Mr. Justice Barrett is praised for having, in the face of popular clamor, laid down the principle that "competitive contracts to avert personal ruin may be perfectly reasonable," and that "only when such contracts are publicly oppressive they become unreasonable and are condemned as against public policy." Upon this principle it is the effect of any monopoly upon the public, and not the mere fact that it is a monopoly, that renders it bad or good as public policy.

In conclusion, it is maintained that most of the legislation upon the subject during six or eight years has been in a temper not conducive to sound legislation; that it is, moreover, "unscientific, impolitic, and fatuous"; that it will not endure, but will go on record "as a monument to the over-zeal of ill-instructed or half-instructed legislators."

The Investors' Dilemma.

THE above is the title of an unsigned article in *The Bankers' Magazine* (London) for April, and the following abstract contains some of the interesting points brought out. Of course, these views are from an English standpoint, but they merit attention.

In spite of the present situation, presenting much that is by no means new or even perplexing, we may well feel that at the present time we are, in many respects at least, passing through a period of "records" in the financial world. We have now experienced the longest spell of the easiest money ever known since statistics on the subject were first compiled. The Bank of England rate has stood at the minimum of two per cent. for more than two years. Consols and other investment stocks have attained to heights hitherto unknown, while side by side we have recently witnessed the most gigantic speculation in mining shares ever known.

Never before probably was there a time when everyone was more genuinely perplexed as to "what to do with his money." For a few years past this perplexity has been experienced to a full degree by bankers, who have—in spite of the reduction of interest on deposits from 1 to ½ per cent.,—found ever-increasing difficulty in profitably employing the balances at their disposal. But now that perplexity is not confined to bankers or the financial community. Everywhere, and on all sides, the problem of an ever-increasing dearth in investment securities yielding a fair return of interest is pressing for solution. Bankers are being continually harassed by solicitations from their customers to invest their surplus cash in something "sound," but yielding from 3 to 3½ per cent. A few years ago such a commission could have been executed in a moment. To-day it is a most difficult task.

British government securities seem to be fast approaching a 2 per cent. basis. English corporation stocks are mostly at prices yielding little more than 2½ per cent., and the same may be said of the debentures of English railways, on which 2⅝ to 2¾ per cent. is now an average yield at present prices.

Neither a solution of the problem thus presented or prophesies as to the probable duration of this plethora of money are attempted. "Even among those who live and move amongst the facts of every-day finance, many are constantly manifesting, in divers ways, that to account for much in the present situation baffles their ingenuity. Why, for example, is it that, with so many millions swept from the market and 'locked up' at the Bank to the credit of Japan, money should still be a 'drug' in the market? True it is that much, and even most, of the Japanese money has been withdrawn from the continent; but this has, again, to some extent, taken the form of lessening continental balances in London. Yet again: why is it, with confidence and credit restored, that money should be more unsalable even than during the period of dullness and stagnation following upon the Baring crisis in 1890?

"That this state of things is the result of the action of economic laws cannot be doubted, and a moment's thought will convince the most superficial observer that the present phenomenally high level of public securities is due more to expansion—we might almost say an inflation—of credit than to the lack of other outlets for cash or other causes which might be assigned."

Whatever may be the numerous causes of this credit boom, it is not satisfactorily proved that the increased output of gold is a potent factor in it. Among the causes, some more obvious than others are thought to be "the comparative lack of any adequate outlets for money; the heavy fall in prices of commodities (due as much to competition and economy in industry as to any other cause); . . . and the financial unrest in America . . . . Credit is but the expansion and the earnest of wealth possessed in some form or other, and this wealth is not only misrepresented by, but is almost apart from, the question of the supply of gold."

The Irrepressible Conflict Between Gas Companies and Municipalities.

We make the following abstract from an address by General Andrew Hickenlooper before the nineteenth annual meeting of the Western Gas Association, held at Chattanooga, Tennessee, May 20 and 21, 1896, the full text of which is printed in *American Gas Light Journal* (June 1). The address sets forth the relations of incorporated companies to the public in a clear and concise way, and is a powerful argument in favor of regulated corporate monopolies as opposed to municipal control of industries supplying the inhabitants of cities with any necessity of urban life.

After a brilliant tribute to the pioneers of the gas industry, the speaker said that for more than eighty years there has been an irrepressible conflict between municipalities and gas companies as to their respective rights, and he formulated what may be styled a creed of economics, applicable to the mutual relations of corporate companies and municipal bodies.

"I believe in the sacredness and inviolability of contracts, and the supremacy of law. I believe that wisdom and intelligence should govern ignorance and superstition with a firmness and decision that cannot be misunderstood. I believe in absolute equality of taxation; no one character of industrial enterprise should be taxed in excess of that of any other industry simply because it supplies a public want. I believe in the granting of properly-conditioned non-terminable franchises for the supply of a perpetual want. I believe in the establishment of regulated industrial monopolies for the performance of any public service that can be as well or better performed than it can be through municipal agencies. I believe that both gas companies and municipalities have obligations that should be observed, and rights that should be respected."

The speaker then proceeded to consider the nature of a monopoly, and the nature of a corporate company, showing that a municipality is also a corporate body, differing in no essential from other corporations. A monopoly is the possession of a privilege or right of exclusive sale, either through engrossment or grant. A virtual monopoly is defined as being a business so related to the great channels of trade and commerce that it becomes in a measure equivalent to a legal monopoly. A regulated monopoly is one which to a certain extent partakes of the nature of a virtual monopoly, and is yet further controlled and governed by legislative or municipal restrictions.

Corporations are artificial persons created by, or under, authority of law from a group of natural persons, and having a continuous existence, irrespective of that of the persons composing it. There are various kinds and characters of corporations, all having one common object,—*viz.*, the accomplishment of some special purpose which can be more conveniently, efficiently, and economically performed through the instrumentality of such an organization than by individual effort.

A municipality is a municipal corporation, a body formed by authority of the State, authorized to act in an individual capacity through centralized power for the purpose of enhancing and protecting the best interest of the members—citizens—of the municipality.

A gas company is a joint-stock corporation, a body formed by authority of the State, and empowered to act in an individual capacity through centralized power for the purpose of protecting and enhancing the best interests of the members—stockholders—of the corporation.

Both gas companies and municipalities derive their powers from the same source and are subject to the same laws, and their governments are substantially the same. Wherefore, then, should one be preferred to the other? If one is to be preferred, what reason can be assigned for the preference? The answers are found in differences in the characters of the men who respectively manage each class of corporations,—a difference that will exist so long as men are chosen for officers in private corporations for their known business ability and probity, and in municipal corporations chiefly on account of their political pull and skill in controlling elections. Business ability and probity are very rarely found joined with political pull. One has only to consider the nature of things to understand this fact,—one of the most conspicuous in history.

The plain common-sense business man is probably not always as intelligent as he should be in regard to municipal needs and requirements; but he "is generally guided in his course by a sincere desire to be fair and honest." The "representative of the purely political element in a community—usually the brightest, best-posted, and most skilful controller of public sentiment," and adroit "manipulator of legislative proceedings"—is "by all odds the best equipped for good or evil," but he is "usually unmindful of the grave and responsible duties of true citizenship, when . . . studying party interests, or the possible effect of any measure which has not . . . the approval of the men upon whom he depends for political preferment." The one labors for the good of the organization of which he is a part and which he represents; the other considers only his own political interests, making these his paramount motives of action. It is not, therefore, difference in fundamental law that makes municipal control of industry objectionable, but difference in the way public and private affairs are, and are ever likely to be, administered.

Paternalism Opposed to Labor Interests.

COMMENTING upon the bill introduced by Representative Sperry, of Connecticut, providing for the classification of clerks in first and second-class post offices, and upon the fact that this bill was introduced at the request of the National Association of Post Office Clerks, *Gunter's Magazine* for June says that the object is not unreasonable, and thinks the bill ought to pass. The bill is directed to the classification of the various workers in the post office in such manner "that they shall have the advantage of promotion from the minimum to the maximum, which now applies to letter carriers."

The New York *Sun* having opposed the measure "on the ground that it is a dangerous precedent to have an association or trades union among federal officeholders," *Gunter's Magazine* makes the following comment upon the *Sun's* argument:

"According to this, the employees of the government are not to have the same opportunities of exercising associated influence to improve their pay that is conceded to all other laborers.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Industrial Sociology in the American, English, and British Colonial Magazines, Reviews and Engineering Journals—See Introductory.

†5956. Recent Legislation in Restraint of Trade. Charles F. Beach, Jr. (The inherent weakness and inutility of existing statutes in restraint of trade are pointed out. It is also shown that as civilization advances, public policy varies in accordance with varying conditions; and that what might have been good public policy in the reign of Henry VIII, might be the reverse in the United States, at the end of the nineteenth century). Am Jour of Soc-May. 6500 w.

†5957. Profit Sharing in the United States. Paul Monroe (An account of results in some fifty different establishments in the United States wherein the experiment of profit sharing has been tried. Some successes and many failures are recorded, and reasons both for success and failure are assigned. The conclusion is that such a system will succeed only with a select few of employers and with a certain grade of skilled or intelligent labor; and that from the point of view of social progress, the system is of little, if any, importance). Am Jour of Soc-May. 11000 w.

†6026. Co-operation in Agriculture. Egerton of Tatton (The question "How far is co-operation in agriculture practicable as a remedy for present agricultural distress?" is answered by a history of organized co-operation in various European countries in the agricultural industries. The article contains a fund of interesting information). Nineteenth Cent-May. 5000 w.

6064. Market Prices and Competition.—Their Origin and Suggestions for Remedying their Evils. Franklin L. Sheppard (An effort to find out the causes of the injurious competition in the stove trade, and to suggest remedies). Ir Age-May 14. 3000 w.

*6111. "Black Lists" (Abridged report from the London *Times* of the recent Trades Union case, in which Messrs. Trollope and some of their workmen brought an action against the London Building Trades' Federation for publishing a "black list"). Arch, Lond-May 8. 4000 w.

6150. Review of the American Iron Trade in 1895; and in the First Four Months of 1896. J. M. S. (From the Annual Statistical Report of the American Iron and Steel Association for 1895. Improvement in business and increase in prices, accompanied by general advance in wages of iron and steel workers, coke workers, and coal miners). Bul of Am Ir & St Assn-May 20. 3000 w.

6198. Business Men on the Sound Money Issue (Editorial remarks discussing and approving the attitude of the Savings Banks' Association (N. Y.), the Cotton Exchange (N. Y.), and the business men of the country generally on the sound money issue). Bradstreet's-May 23. 1000 w.

6199. Bill Restricting Immigration Passed by the House (Editorial comment upon the

McCall bill which provides for an educational test). Bradstreet's-May 23. 500 w.

*6219. Continental Competition. William Jacks (Paper read at meeting of British Iron Trade Assn. Abstract of a general review and discussion of the situation and of the economic conditions of the British and continental iron industries). Engng-May 15. 4500 w.

†6228. The Sweating System. Henry White (What it is. Legislation relating to its regulation and suppression, and other general considerations). Bul of Dept of Labor-May. 9000 w.

†6229. Recent Reports of State Bureaus of Labor Statistics (Summaries of reports of bureaus, Massachusetts, Missouri and Utah). Bul of Dept of Labor-May. 2200 w.

†6230. Recent Foreign Statistical Publications (General report on the wages of the manual labor classes in the United Kingdom, with tables of the average rates of wages and hours of labor of persons employed in several of the principal trades in 1886 and 1891). Bul of Dept of Labor-May. 5000 w.

†6231. Annual Statistical Abstracts (Tables of contents of abstracts or summaries of results of inquiries made by various bureaus by different governments throughout the world). Bul of Dept of Labor-May. 2500 w.

†6232. Decisions of Courts Affecting Labor (Current decisions in the different States briefly summarized). Bul of Dept of Labor-May. 12000 w.

*6234. The Democratization of England. Thomas Davidson (The change going on in England for the last thirty years and toward democratization, is reviewed, and its causes are found to be (1) economic, (2) literary, (3) ethical, (4) philosophic. The most prominent associations acting to bring about this change are named, and the character of the work of each is described. The England of the future, so far as its features can now be discerned, is outlined). Forum-June. 4500 w.

*6258. The Recovery of Our Industrial Supremacy in the Trade of Ironmaking. B. H. Thwaite (Showing that the natural advantages of England in this field are unrivalled, and examining the causes for alarm and for inability to compete with other countries. The cost of carriage, and the difficulties with British workmen are considered of greatest importance). Ir & Coal Trs Rev-May 15. 1800 w.

*6265. Labor Legislation in the United States. Horace G. Wadlin (The labor legislation is roughly classified under three heads; (1) those affecting the health education and moral welfare of the worker; (2) those insuring personal safety in the performance of work; (3) those enforcing duties and obligations between the employer and employed) Chau-June. 3700 w.

*6266. Labor Unions in China. Walter N. Fong (Interesting account of these unions and their objects, and peculiarities). Chau-June. 2700 w.

†6267. English Industries and German Competition (Superior technical training, not cheaper labor, is held to be the secret of Germany's capacity to compete with English industry). Consular Repts-June. 900 w.

†6268. German Advertising in Japan (Account of a new German trade paper, printed in Japanese, and of the exceedingly strong effort now put forth on the part of Germany to secure Japanese and Chinese trade). Consular Repts-June. 700 w.

*6269. The Italian Woollen Industry (Particulars derived from an official publication of the Italian ministry of agriculture, industry, and commerce). Bd of Tr Jour-May. 2000 w.

*6270. British Trade With Egypt (From a report of Mr. Rennell Rodd, Her Majesty's Secretary of Legation at Cairo). Bd of Tr Jour-May. 4000 w.

*6271. The American Sardine Industry (Interesting details of a flourishing trade). Bd of Tr Jour-May. 1100 w.

*6272. Foreign Competition with English Interests in Japan (Review of a report by Mr. Gerald Lowther, British Secretary of Legation at Tokio). Bd of Tr Jour-May. 2800 w.

*6273. Argentine Republic Customs Law (Translation of full text of the law). Bd of Tr Jour-May. 1800 w.

*6274. Tariff Changes and Customs Regulations (Includes Russia, Sweden, Germany, Belgium, France, Algiers, Portugal, East Africa, Spain, Italy, Roumania, United States, Nicaragua, Mexico and the Bahamas). Bd of Tr Jour-May. 7500 w.

6356. Municipalities vs. Gas Companies: Their Reciprocal Relations. Andrew Hickenlooper (It is shown that private companies are subject to the same governmental control as municipalities, but that the latter have less opportunity and are, therefore, less likely to evade law than municipalities). Am Gas Lgt Jour-June. 15000 w.

†6365. The Outlook for Silver. Dr. Otto Arendt (The views of one of the ablest German advocates of bi-metallism are presented in this article). N Amer Rev-June. 8000 w.

*6367. Bishop Potter as an Arbitrator (Editorial review of Bishop Potter's action as arbitrator in the recent strike of lithographers in New York city. In the main, commendatory). Gunton's Mag-June. 2000 w.

*6368. The Groningen Land Lease System. James Howard Gore (This interesting article was written in the belief that the subject of perpetual leases, as exemplified in the Groningen land lease system, has not before found a place in American sociological literature). Gunton's Mag-June. 3000 w.

†6370. Architects and Trades Unions. Dankmar Adler (The relation of the architect to the unions, and the necessity of employing union labor when buildings are to be completed on time contracts). In Arch-May. 1400 w.

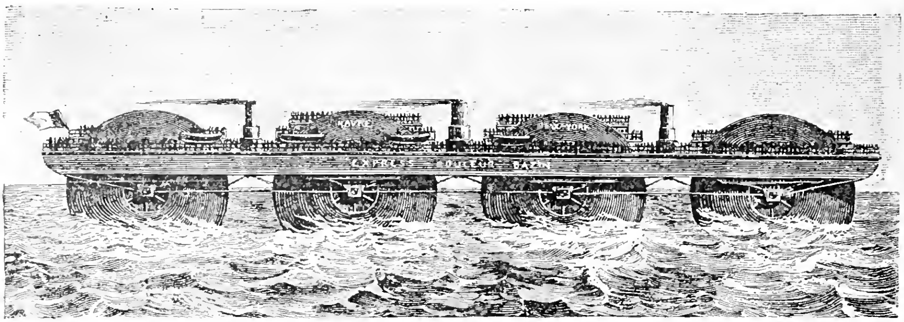
6442. The Bad Citizenship of the Good Citizen. George W. Ochs (All our municipal ills are herein traced to the failure of the better class of citizens to take their full share in active municipal government). Public Opinion-June 4. 1400 w.

MARINE ENGINEERING

The Bazin Disc-Wheel Steamboat.

THE device described herein (*The Engineer*, London, May 15) must not be confounded with the boat on rollers, which is a very ancient device, or with others of more recent date, as it is believed to be a new departure. It has the rollers in common with its predecessors, but in the method of propulsion it is very different. Boats on rollers have been pushed forward with various means of propulsion. Many of them have had revolving rollers with floats or paddles; but no one up to this time, except M. Ernest Bazin, appears to have conceived the idea of moving such a boat by a propeller independent of the rollers or wheels, and at the same time rotating the wheels, the latter not propelling at all, but simply rotating in relation to the forward movement of the boat.

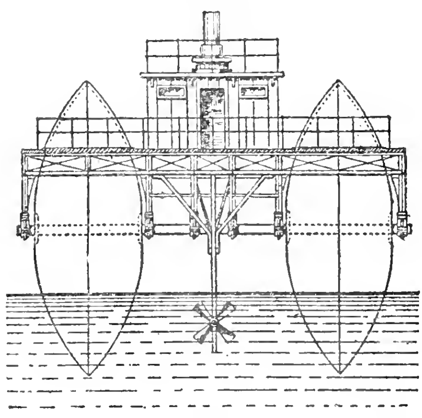
He was led up to this idea by the following experiments: "First, a hollow wheel was placed in a tank, and it floated vertically with about a third of its bulk immersed. Spun round without any forward movement, the wheel continued to revolve for some time without moving from its place, and this proved to M. Bazin that he could not rely upon the revolution of the wheel alone for the propulsion of the vessel. He then pushed the wheel forward without revolving it, and the effect was exactly the same as with an ordinary keel,—that is to say, it threw up a good deal of water in front, and left a trail behind. Moreover, it only advanced four or five feet, and did not show the slightest tendency to revolve. This convinced M. Bazin that he would have to give to the wheel both a revolving and a forward motion. Thereupon, spinning the wheel and pushing it forward, the hollow disc travelled the whole length of the tank with scarcely any agitation to the water whatever. Still pursuing the experiments, the inventor gave a more convincing illustration of the absence of any resistance and friction with the revolving disc. Two sticks were placed in the water, and a disc was propelled horizontally. On meeting the sticks, the wheel pushed them forward a few inches, and then stopped. Repeating this experiment with a revolving disc, the wheel passed over the sticks, which sank under the wheel and rose at the identical place, while the disc continued its course to the end of the tank. After thus proving that the wheel must have both a revolving and a forward movement, M. Bazin soon found that nothing was to be gained by revolving the disc too quickly, and that it was merely necessary to do this in proportion to the propelling force of the screw. If anything, too much power upon the wheels would be likely to cause a certain amount of friction. Under these circumstances, the relative power upon the propeller and the wheels would have to be calculated with a certain nicety, as the discs would have to turn in exact proportion to the distance covered by the boat. This fact having been settled, M. Bazin proceeded to demonstrate the stability and speed of the wheels. A framework carrying six disc wheels, three on each side, was placed in the tank. A cord was attached to it and drawn up over a pulley, and carried a weight of 200 grammes, which represented a certain propulsive force. The frame was pulled back to one end of the tank, and allowed to go forward by the action of the weight at the end of the cord. According to the watch, the time occupied in travelling the whole length of the tank was twenty-three seconds. The same experiment was then repeated with the wheels revolving by clockwork, and, though losing two or three seconds at the start before getting up full speed, the apparatus went from one end of the tank to the other in eleven seconds. By comparing these results, M. Bazin estimates that the speed of a disc wheel steamboat would be 31 or 32 knots, while the smaller power required results, according to his estimate, in an economy of about 66 per cent. of coal. One of the advantages claimed for the system is the practical impossibility of sinking. Supposing that one or two, or even more, of the wheels were perforated in collision, the vessel would not do more than sink a few feet,—a fact which was exemplified by removing the plugs from two of the wheels, and allowing the water to



BAZIN DISC-WHEEL STEAMBOAT.

enter. As soon as the water had entered to a certain height in the wheel, it turned up with the orifice at the top, thus permitting of the damage being repaired with the greatest ease. Meanwhile, it would be possible for the vessel to proceed at reduced speed."

An exhibition of a working model, built



to one-twenty-fifth the size of a proposed transatlantic boat (to be one hundred and twenty meters long) was recently made by M. Bazin at his Levallois works. "The deck or platform represents a height of six or seven meters above the sea, while the upper deck is about 13 meters above the water level. The deck itself is built up with girders, and, being hollow, it has an enormous carrying capacity, either for merchandise or coal. There are eight discs or floats, four on each side, and, owing to their convex form, they offer little resistance to the wind, while the head wind has a clear passage underneath the deck. In appearance the model is very elegant, and certainly destroys any prejudice that might be entertained against the form of the vessel. The motive power was supplied by dynamos, one working the propeller and four others turning the floats. Upon the connection being made, the propeller revolved with great rapidity, and the wheels turned slowly, and, after a few seconds lost in getting under weigh, the model sailed the whole length of the basin at great speed. To show the conduct of the vessel in rough weather, the water was agitated to represent waves, on the same scale as the model, of five to seven meters in height, and, though rolling slightly at her moorings, the model behaved splendidly when in motion. The miniature waves rose nearly to the level of the deck, but the model rode as steadily as in the previous experiments. It is claimed that in the roughest weather the passengers would feel very little movement of the vessel. In the experimental boat now being constructed the steering is done with an ordinary rudder, but it is proposed to steer the transatlantic vessels by means of a column of water forced out of the stern by a pump, so that, instead of the progress of the vessel being impeded by the resistance of a rudder, it will be assisted by the water thus expelled at the stern. On the boat taking up its berth, it may be driven by the steering gear alone, and this acts, it is alleged, so efficaciously that the vessel can be turned round its own length."

Admiral Coulombeaud, who is reputed to be one of the first of French naval authorities, is said to be a firm believer in the possibilities of M. Bazin's invention. A boat of this kind, of a size sufficient for the channel passage between France and England, will probably be launched in July, and make its trial trip very soon thereafter.

The first of the illustrations accompanying this description is intended to show a side view of a transatlantic vessel of this sort. The second is a diagrammatic end-view, showing the way in which the deck is supported by the axles of the wheels. It is asserted that Admiral Coulombeaud has computed that only one-twenty-seventh of the power required to drive an ordinary boat is needed for a Bazin craft of the same size and speed.

All this will be regarded with much reserve, until an actual trial shall prove the system to be practical or otherwise.

Mineral Oils in Marine Boilers.

An editorial dealing with this subject (*Engineering*, London, May 22) contains so many interesting particulars that we recommend its perusal to all steam engineers, whether stationary, locomotive, or marine. Marine engineers, who are obliged sometimes to use salt water as supplementary feed, will, perhaps, be more interested than others.

The instances of collapse of boiler furnaces during the last fifteen years are noted, and the tendency to refer this to the use of mineral oils for lubrication, as the ultimate cause of the mischief, is mentioned. It is a curious fact that most of these collapses have occurred in new steamers.

Animal and vegetable oils were supplanted by mineral lubricants, because the former were deemed injurious to boilers; but, if, as many now suppose, the mineral substitute is also injurious, there is reason in the practice of running engines without lubrication of cylinders or piston rods, these being the parts which, when lubricated, introduce the oil into the steam passages whence it finds its way to the boiler.

In the multiple-expansion engines oil is mostly introduced by the low-pressure piston rod, partly because of the vacuum, and partly because the packings are slack. The latter cause could be rendered less effective by tightening the glands, but there are practical difficulties in the way of applying this method.

"Leakages at the high-and mean-pressure glands are at once detected on account of the escaping steam, but the low-pressure glands have to be tightened up by guesswork; and to be on the safe side the engineer does not go too far. It would also seem as if the low-pressure piston-rod, perhaps on account of its comparatively low temperature, has a tendency to get covered with a sort of greasy scale, which unquestionably assists in abrading the packing. Both these difficulties might be overcome, if the bushes of these glands could be made a good fit around their respective piston-rods, and could be maintained in this condition; but this is practically impossible on account of the large amount of play which exists between the guides and crosshead shoe when the engine is hot."

The use of oil filters for feed water, even by those who no longer lubricate cylinders, is deemed practical proof that the oil introduced by the piston-rods is not negligible. An interesting recital of the conditions in which boilers are found follows, for the full text of which the article must itself be consulted. A hint at the probable cause for the collapsing of furnaces in new steamers is given.

"If much oil has been let into the boiler, the whole internal surface is distinctly greasy, and the water level is filthy. One or the other of these two last conditions is the most likely one to exist in new steamers; and, as it is new steamers which have most frequently collapsed their furnaces when neither ordinary scale was on the plates nor salt in the water, it is but natural to suppose that these mishaps have been caused by the thin film of grease and rust. In its charred, or semi-charred, condition mineral oil probably partakes more and more of the non-conductive properties of its near relative, hard paraffin, or possibly, under the conditions of high pressure and temperature, it may possess the property of swelling out into large bubbles containing superheated steam or hydrocarbon vapors, and covering the heating surface. In either case the heated plate between this film and the fibre is robbed of all cooling contact, it gets hotter and hotter, and collapses if it forms part of a furnace."

A more reasonable explanation is, however, found in the high non-conductive properties of the greasy film. Other considerations seem to indicate that neither of these explanations is of itself adequate. One of these is the inexplicable fact that "it is rare to find only one furnace in a boiler which comes down, or that the furnaces of one boiler only have come down, but, on the contrary, all the furnaces of all the boilers usually come down together."

Suez Canal Traffic.

RECENT authoritative detailed statistics in the *Board of Trade Journal* (London) for May show that the percentage of British vessels using the Suez canal has been falling off since 1893; there has been also a steady decrease in the total traffic. The figures for the total are 2,318 ships in 1895, having a tonnage of 8,382,075; 2,386 ships in 1894, having a tonnage of 8,326,826; and 2,405 ships in 1893, with a tonnage of 7,977,728. It is thus seen that, while the number of ships is less, the tonnage has slightly increased. The percentage of British tonnage was $74\frac{2}{10}$ in 1893, $73\frac{8}{10}$ in 1894, and $70\frac{8}{10}$ in 1895. The percentage of German tonnage has increased. The number of ships passing through the canal during the month of February last was 276, of a gross tonnage of 970,066 tons, 258 of which showed a tonnage of 868,714 tons. Of these vessels 171 were English (637,658 tons), 28 Italian (82,391 tons), 24 German (82,100 tons), 18 French (68,677 tons) 17 Dutch (43,103 tons), 7 Austro-Hungarian (23,411 tons), 5 Spanish (20,740 tons), 2 Russian (8,148 tons), 3 Ottoman (2,614 tons), and 1 Norwegian (1,224 tons).

The Forban Criticised.

THIS small French vessel,—the fastest ever put in the water (she made 31 knots per hour)—while she is admitted to be a credit to her constructor, M. Normand, is still criticised by practical men as little more than a marine toy, of no significance as regards the future of either marine warfare, or of marine passenger traffic. A boat 144 feet long, and carrying 4000 horse power to make the speed named seems altogether preposterous except perhaps for some special service in marine warfare.

A correspondent of *The Engineer* (London) puts the vessel on its proper footing as a scientific toy rather than a practical seagoing vessel, and leaves it for naval officers to conjecture what possible useful purpose such a boat could be made to subserve. At the same time he admits that the performance of the boat is admirable, much better than that of another boat 210 ft. long which does 30 knots, "because the square roots of the respective lengths point out the proportionate speed of similarly proportioned vessels with proportionate power, and, consequently, the 210 ft. boat should have had a speed of 37 knots, with power in proportion to her tonnage. The Forban required about 4000-horse power, and so the 210 ft. boat would have required about 11,000-horse power to go at 37 knots speed. This is probably about double what the 210 ft. boat really had to dispose of."

But it is said that the bunkers of the Forban can hold only fifteen tons of coal, and half her displacement is due to the weight of her machinery. Fifteen tons of coal for 4000 horse-power represents short runs only, mere spurts, which might be of some service in a harbor police boat, and this only on rare occasions.

The correspondent above quoted, seems to think the kind of fuel had something to do with the speed attained. He says: "The British Admiralty compels contractors to use ordinary coal on trial-trips, and on low-speed consumption trials the fire-grates must not be materially reduced.

Not so in France; there the low-speed consumption trials, which determine the quantity of coal the bunkers must contain may be made with very largely reduced grates, and thereby of course, a considerable economy is attainable. Again, in France contractors are allowed to use a special class of fuel, viz., briquettes made of pulverized coal, out of which the earthy particles have been carefully washed, the coal being then mixed with certain tarry substances to make it cake in the process of hard pressing into briquettes. By such means it is possible to manufacture a fuel which far surpasses Welsh coal in power. It would be very interesting to try what speed could be got out of the Forban on a *three* hours run—not one hour—with ordinary Welsh coal, say Nixon's navigation. I fancy that 28 knots would be more likely than 31, for after a short time the bars would be nicely clinkered over when burning at the rate of probably one hundredweight per square foot of grate per hour. The total duration of the Forban's trial seems to have been about one and a-half hours only. In England a three hours' trial is exacted."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Marine and Engineering Journals—See Introductory.

*5967. Coast and Lighthouse Illumination in France. C. S. Du Riche Preller (The first part, which deals with the recent great extension of the French coast-light system, and gives an illustrated statement of three different systems of classification of lights with their characteristics, indicates that the series will be of more than ordinary interest). Engng-May 1. Serial. 1st part. 2800 w.

*6009. The Rule of the Road at Sea (Editorial review of the report of a select committee of the British House of Commons appointed to consider the rule of the road at sea, which is regarded, with slight modifications, as the work of Sir Robert Reid. New rules have been formulated and approved by all the officers of the navy, after a conference at Washington of representatives of European powers and of the United States). Trans-May 1. 1500 w.

6034. A Great Lake Shipyard (Illustrated description of Messrs F. W. Wheeler and Co.'s extensive works at West Bay City. One of the finest vessel building plants in America). Sea-May 14. 900 w.

6096.—$1.25. Contract Trial of the United States Coast Line Battleship Massachusetts. C. H. Hayes (Full illustrated description of trial with extensive tabulated data). Jour Am Soc of Nav Engs-May. 8500 w.

6099.—$1.25. Forced Draft Trial of the U. S. S. Raleigh. C. R. Roelker (Full description of trial with diagram, speed curve and brief table of economic performance). Jour Am Soc of Nav Engs-May. 1400 w.

6100.—$1.25. Calculation of Horse-Power for Marine Propulsion. Thomas English (Read before the Inst. of Mech Engs. A method whereby, with the ordinary appliances of a shipyard, results can be closely approximated, that could be obtained otherwise only by the use of the refined apparatus of a model tank. Illustrated with diagrams. Discussion). Jour Am Soc of Nav Engs-May. 2000 w.

6101.—$1.25. The Battle of the Yalu and Its Effect on the Construction of Warships. L. Ferrand (Abstract of a paper read before the Assn. Technique Maritime. In this paper the author reaches the conclusion that the true battleship of to-day can be a sort of monitor, only completely armored, low in the water, invulnerable against light artillery, powerfully armed and with speed sacrificed to protection and armament). Jour Am Soc of Nav Engs-May. 1700 w.

6159. The New Steamboat Adirondack (Illustrated detailed description). Am Ship-May 21. 500 w.

6167. The Long Island Sound Passenger Propeller Middletown, Built by the Neafie & Levy Ship and Engine Building Company of Philadelphia (Illustrated general description). Sea-May 21. 600 w.

*6236. Auxiliary Engines in Screw Steamers (Not only auxiliary engines but other marine engine accessories are discussed in this article). Eng, Lond-May 15. 3500 w.

*6242. The Bazin Disc Wheel Steamboat (Illustrated description). Eng, Lond-May 15. 1700 w.

*6325. The Problem of Speed. M. J. A. Normand (A paper read before the Maritime Technical Assn. An examination of the speed of torpedo vessels from a general point of view, and of the Forban in particular). Eng, Lond-May 22. 3000 w.

*6329. Mineral Oil in Marine Boilers (Editorial. A general review of the present status of practice with reference to the effect upon marine boilers of mineral oils used in the lubrication of engine cylinders). Engng-May 22. 3000 w.

*6330. The Russian Auxiliary Cruiser "Kherson" (Editorial comment upon the recent trial of the ship named and upon the performance of the Belleville boilers with which she is fitted). Engng-May 22. 2500 w.

*6449. The New Liverpool Landing Stage (Illustrated description of a floating stage at dock and a recent large extension of the same). Eng, Lond-May 29. 1500 w.

*6458. The Argentine Cruiser "Buenos Aires" (Illustrated detailed description). Engng-May 29. 900 w.

We supply copies of these articles. See introductory.

MECHANICAL ENGINEERING

Invention: Is It a Myth?

In its issues of April 4 and 11 *Mining and Scientific Press* published a well-written article by Mr. W. H. Smyth, a mechanical expert and consulting engineer of Berkeley, Cal. This writer takes the ground that invention is an "indefinable requirement of the patent law." Many will agree that cases constantly arise wherein it is difficult, if not impossible, to determine whether a device is, or is not, an invention. It will also be admitted that, like many other words in common use, an exact definition of invention is perhaps impossible. This, however, does not prove that the word is not useful, or that its use is always or even generally misleading. For example, the two words "*animal*" and "*vegetable*" are in common use, and we could not dispense with them or some substitute for them; yet neither of these words is exactly defined, and there are cases of disagreement among experts as to the proper classification of some living things.

We have laws relating to the living and the dead. It is lawful to bury or to cremate the dead, but not the living. Practically no serious difficulty arises in the application of these laws; but the words "*life*" and "*death*" have never been exactly defined. Some things are alive; some things are dead; yet there is a borderland wherein the ablest biologists are unable to say with positiveness whether objects are, or are not, alive. The same practical difficulties arise in the interpretation of laws relating to the insane. Sanity and insanity have never been so exactly defined that we can always determine which of these terms ought to be applied to the state of mind observed in a particular case.

We might thus go on multiplying examples of indefinability; any one who does this thoughtfully and candidly will arise from his task surprised at the number of facts in all the relations of society, in the useful arts and in the sciences, that have never yet been exactly stated. Yet these facts must be stated in some way,—as perfectly as our faculties and knowledge permit,—because they are facts of constant experience. In the conclusions drawn from the statements made in these imperfect terms of expression, human judgment must supplement imperfect definition; and there is scarcely an hour of active life in which human judgment does not so act. Were it not so, experience would count for nothing, and the calling of the expert would cease to exist. It is the function of the expert to form better judgments and juster conclusions from imperfectly-stated facts than can be formed by those who have less knowledge and experience.

We may, therefore, freely admit that the word invention cannot be exactly defined; but we do not therefore admit that either the practical details of human life, or legal enactments, can on that account dispense with the term; and we dissent from the views expressed in the following quotation, although we readily admit that, in their support, Mr. Smyth has presented a very ingenious argument. After stating the statute provision that "the subject of a patent must be not only new and useful, but must also be an *invention*," the author says:

"It is my intention to show that, though the third requirement has always been in the statute, and its meaning substantially the same as the present interpretation, until recently it has practically been a dead letter.

"Further, that it is not by any means axiomatic that the third requirement is in any case *possible* of *fulfilment*, but, on the contrary, there are many cogent reasons for questioning whether 'invention,' like 'spontaneous generation,' is not a metaphysical myth.

"That, even if it be in fact a real quality, *it has never been defined;* nor is it of such a character that its presence can in any case be determined beyond doubt. All authorities agree that 'questions of invention proceed upon fine and subtle metaphysical distinctions.'

"Strangest of all, the law and practice relating to patents, which provides this requirement involving metaphysical distinctions, also provides that decisions relative to these philosphical subtleties shall be rendered by mechanics, chemists, lawyers, etc., but never by expert metaphysicians.

"That, in effect, the patent office examiners and judges decide these questions arbitrarily. So the third requirement works injustice in all cases, but particularly in those involving the results of the highest and best form of mental industry, which the patent law was particularly designed to foster.

"And that it should be removed from the statute and the idea eliminated from the practice both in the patent office and courts."

With reference to the first of these propositions, it is not established by Mr. Smyth's argument that the requirement that the thing sought to be patented should be an invention has been until recently "a dead letter." Examiners in the patent office, if competent, have always taken this point into consideration, and have decided it one way or the other, as best they could, within the limitations of their knowledge and capacity for forming judgment.

Second, with reference to the possibility of determining the fact whether the subject of an application for letters patent is really an invention or not, we believe, in spite of what Mr. Smyth says in support of this view and the numerous examples of confusion of thought culled from decisions and writings,—some of them from high authorities,—and cited by him, that, in the great majority of cases, an average man, by the exercise of common sense and judgment, may determine whether the subject of a patent is, either in whole or in part, the result of invention or not. Similarly, the exercise of common sense and judgment would determine the question of sanity or insanity in the large majority of cases. Cases in which the average mind would be at fault are such as must be determined by experts; and patent examiners are, or should be, experts.

The third proposition has already been admitted as true; but, if all questions arising in civil or criminal law in which indefinable terms (that is to say, terms that can be defined only in a general way) are involved are to be decided only by a jury of "expert metaphysicians," there will soon be an end of much that is essential to the administration of justice in society. While society is made up of "mechanics, chemists, lawyers, etc.," it is not, and never will be, composed of expert metaphysicians; and, if it could be, it might well be doubted whether the administration of public business in ordinary affairs would be improved by the metaphysical mind.

Lastly, if the word "invention" should be "removed from the statute, and the idea eliminated from practice both in the patent office and the courts," we should be compelled to substitute for it some other equally indefinable, and therefore equally objectionable, term. Our language and thoughts would be strangely crippled, were the same thing to be done with all other words which cannot be exactly defined.

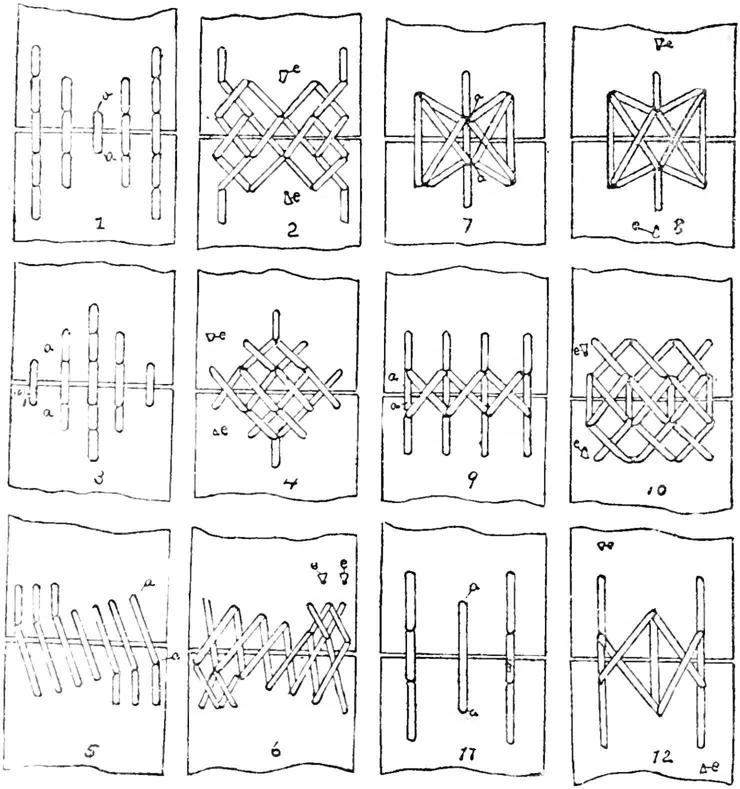
Odd Belt Lacings.

Mr. B. F. Fells, in *American Machinist* (May 28), presents some unusual schemes of belt-lacing, each of which, he says, has its advocates, although it is hard to conceive a reason for the existence of some of them. We have reproduced, on a somewhat smaller scale, the diagrams illustrating these odd lacings (some of which may certainly rank among mechanical curiosities), and Mr. Fells's description, also somewhat condensed, from which any one used to lacing belts will be able to produce each of the examples.

For making the lacing numbered 1 and 2, "about all the instruction that the ordinary man needs is that the holes be punched even and uniform, and that elastic lacing be used, the straight laces being run against the face of the pulleys. No. 1 is the front of this union, and No. 2 the back. The starting point for the lace is at *a a*, and the sewing can be worked toward either side, coming back by crossing on the back, and going to the opposite side to return to the center again, where the union is completed and the ends of the lace brought out at *e e*." Mr. Fells regards this lacing as essentially weak, and we think that most mechanics will agree with him.

"Nos. 3 and 4 appear to be a substantial lacing for light work and general purposes, and easily and quickly made. The

"No. 7 comes from a saw-mill man. It is loose and easily made, and adaptable for ordinary work. When belts that have considerable work to do are laced on this principle, a double sewing, or extra strong lacing, is required. Scratch two lines across each butt, about half an inch apart, and the inner line same distance from the edge of the butt. Then punch the holes at stated distances, and draw in the laces according to the diagram, beginning at *a a* and finishing at *e e*, No. 8, which is the back,



ODD BELT LACINGS.

lacing can be readily done by commencing at *a a* in No. 3, and working to the opposite side in the manner shown on the back of No. 4, finishing at *e e*.

"Lacing No. 5 is quite odd. It is claimed that this will hold longer on quarter turns than some other kinds. It is made by beginning at *a a* with both ends of the lace, and lacing toward the other side, as indicated on the back of No. 6, ending at *e e*.

on which the laces are crossed as on the face, owing to the double-lacing system.

"The maker of lacing Nos. 9 and 10 aims to distribute the strain of the lacings over as wide a surface as possible. To lace this, use a reliable lace and insert an end into holes *a a*, drawing the lacing through so that each end will be of the same length; then one of the ends of the lace down through the hole in front of last, up through opposite hole, and down through next hole beyond that, thus working the lace into the series of holes straight through, winding up at *e e*. Be sure the laps do not ride; do not draw the laces as tightly as you can; be careful not to get the laces twisted anywhere.

" A millwright sends in the sample Nos. 11 and 12. It is made by starting at *a a* in No. 11, and at *e e* in No. 12, which is the other side."

Apparatus for Blue Printing.

AN unsigned article in the *Practical Engineer* (May 15) says, with reference to the method of holding tracings over sensitized paper in blue printing, that it is a comparatively easy matter to obtain a good contact between a small negative on glass and the paper, but it is not so easy to deal with several square feet of tracing cloth and a corresponding area of sensitized paper. Notwithstanding this, the general tendency is to adopt large sheets of plate glass fitted into heavy wooden frames. A piece of thick felt is pressed against the paper by means of a flexible board, acted upon by some simple form of spring. This apparatus produces a good contact and sharp definition when carefully handled, but at the best it is clumsy, and the glass plate is always liable to fracture.

An improvement in this frame, and one which obviates the use of springs, is the addition of a rubber bag, which can be inflated after the tracing and photographic paper are in position, thus bringing them into close contact with the glass. This, however, adds to the first cost, and does not enhance the durability of the arrangement. With the not too careful usage of the office boy, the rubber deteriorates, and usually announces the fact by allowing the air to escape slowly during the process of exposure, thus buckling the tracing and spoiling the photograph. Instances are cited where tracings ten feet long have been satisfactorily photographed by means of two revolving rollers. The first roller may be about nine inches in diameter, covered with thick felt and a round of cartridge paper. Having mounted this roller upon a suitable axis, the tracing cloth, together with a continuous length of sensitized paper, is wound tightly upon the cylinder. The free end is attached to the second roller, upon which the cloth and paper are wound as the exposure is completed. With rapid paper, such as is now procurable, and a good sunlight, very good results may be obtained in this way with an exposure of about three minutes. Some simple way of revolving the rollers uniformly will readily suggest itself as suitable.

While this method is suitable for reproducing tracings of unlimited length, it is, of course, quite out of place in the ordinary routine of drawing-office work. An arrangement has been patented in Germany by which the air is exhausted by means of a pump from between a sheet of glass and the tracing cloth, in order to produce close contact, but this method is not favored. There is a simpler and inexpensive way of obtaining good results. Procure a well-flattened piece of ⅛-inch iron plate of the required width and length. Cover this with thick felt on one side by means of a cement or special glue. Cut off two stiff boards the same length as the iron plate, and batten them together side by side. The plate may then be laid upon these boards, and the tracing with the sensitized paper clamped to the felt side of the iron plate. Taking hold of the edges of the plate in the middle will cause it to deflect into a circular arc, drawing the creases out of the tracing cloth. Suitable notches cut in the boards to receive the lower edges of the plate will cause the latter to stand as an arch, with the tracing upon its upper surface. If the tracing is well clamped to begin with, a very slight curvature suffices to bring it into good contact with the photographic paper; this being so, the intensity of light all over the surface is fairly uniform. If necessary, the iron may be sprung in the reverse direction, to assist in taking out the creases and reducing the final curvature. Enough has been said to indicate the means of dispensing with expensive frames and large sheets of glass. With minor details conveniently arranged, the method described cannot fail to commend itself to any practical draughtsman.

Conductivity of Boiler Scale.—A Correction.

In our June number two of the cuts (Figs. 3 and 4) illustrating experiments on conductivity of boiler scale were, by inadvertence, omitted. They are presented herewith, with description.

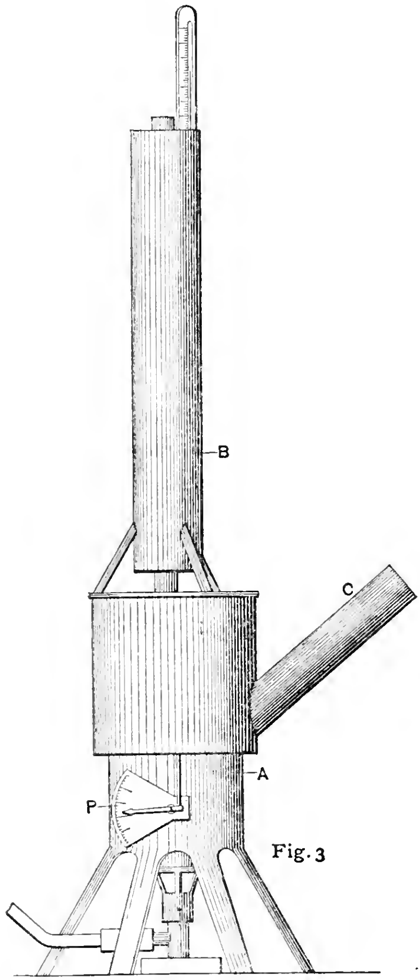


Fig. 3

Figs. 3 and 4 are views of an apparatus for testing the heating efficiency of clean and coated tubes. A small sheet-iron furnace A is heated by a small gas stove or Bunsen burner; on top of the furnace stands the vessel of water B. This vessel is about 1¾ inches in diameter and about 25 inches long. In the interior of this cylinder is a tube extending through the bottom of the cylinder into the top of the furnace and 1-32 of an inch thick and about 5-8 of an inch outside diameter, reaching from about one inch below the bottom end to a little above the top end of the cylinder. The ratio of the diameter to the length of this tube is about the same as that in ordinary boiler tubes.

There were several of these cylinders made; the dimensions and weight of the metallic parts were similar in every respect. Two of these vessels were left clean, but in one there was 3-32 of an inch of plaster of Paris coated on the tube, in the same way in which scale coats a boiler tube; in another vessel 1-4 of an inch of Portland cement was coated on the tube. The tendency of the heated gases from the flame will be to go through the tube in the vessel of water, but, as the capacity of this tube is not great enough to carry off all the gas, some must make its exit by coming down between the outside and inside casings of the furnace and flowing out through the chimney, C.

This chimney carries the surplus of heated products to such a distance from the vessel of water that there is no chance for the outside of the water vessel to act as a heating surface by receiving heat from rising hot gases. In the top of the furnace and directly under the tube is a pyrometer, P, which, though not indicating the degrees, serves to indicate changes in the temperature at the top of the furnace. This pyrometer is made of a small strip of brass riveted to a similar strip of iron, one end being secured to the side of the furnace, while the other is connected by a wire to a pointer that moves over a graduated scale. Unequal expansion of the brass and iron bends the riveted strips, the pointer indicating temperature. In the water at the top of the vessel is placed a thermometer.

Referring to the experiments described in our June number, *Power* says that "if relative conductivity determined the ratio of efficiency of heating surfaces, it would appear, then, that the water vessel with a clean tube will heat up in 4-26 of the time that it takes to heat the water vessel with its tube coated with 3-32 of an inch of plaster of Paris. That such ratios would be incorrect is shown by the following: To heat from 64° to 205°, it took the water vessel with a clean tube 13 minutes and 10 seconds, and with the vessel in which the

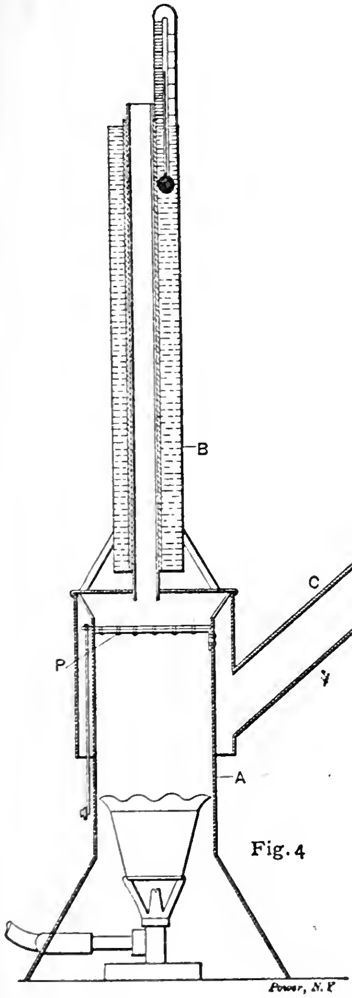


Fig. 4

tube was coated with plaster of Paris 3/32 thick there was no appreciable difference in the time required to heat the same quantity of water. The gas flame was the same in each of these tests, and the pyrometer showed that the temperature of the furnace had not varied."

The experiments were varied, but the indications were the same. It is admitted that the apparatus is rather a crude one, but there can be no mistake in the significance of the indications. When a conductor has sufficient conductivity to conduct from one side to the opposite side all the heat applied to the receiving side, no increase of its conductivity can make it conduct any more heat than is applied to the receiving side.

Annealing Steel.

THE AMERICAN ARTISAN, having stated that for annealing steel there is no better material than charcoal, is courteously reminded by *The Engineer* (New York) that some kinds of steel cannot be thus annealed. The editor of *The Engineer* was formerly interested in the sale of steel for manufacturing purposes, and, in discussing the point thus raised, he favors his readers with an interesting and instructive leaf from his own experience. He says: "In 1865 we sold a quantity—forty tons—of decarbonized gun-steel to a Rhode Island firm, for making rifle-barrels. This steel was all cut to short lengths, and was useless for any other purpose. It was annealed by the buyers, and, when they came to drill it, it was found impossible to touch it with a tool. The steel was rejected, and held subject to our order. This was a serious matter, for at that time steel was worth something like ten cents gold. We were sent to investigate the method of annealing, and found that it had been treated in the manner described above. This seemed to us the cause of the trouble, for, as we argued, annealing decarbonized steel in charcoal for a matter of three days (heating and cooling) turned it into cemented steel, and it had the appearance of it when broken; a bar of it, struck across an anvil smartly, broke like glass, with a crystalline fracture. We ordered all the steel reannealed in spent gas-house lime, used in the purifiers, we believe, of which large quantities can be had for nothing. This proved entirely satisfactory, and the steel worked perfectly under every tool. Spent gas-house lime is the best vehicle for annealing steel we ever found or heard of; the steel is more like lead than steel, and its hardening qualities and durability are unimpaired. Twenty-four hours—even twelve hours—are sufficient to anneal the steel in lime."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

The Machine Shop.

6061. Utility and Advancement of Green, Dry Sand, and Loam Molding. Thomas D. West (Read at the first National Convention of Foundrymen. On the different methods, and a knowledge of general principles being necessary to enable the molder to determine which method was best for any piece of work). Ir Tr Rev–May 14. 1700 w.

6065. Foundry Cranes. A. E. Outerbridge, Jr. (Fundamental practical considerations common to all cranes are discussed and essential qualifications are set forth). Ir Age–May 14. 1600 w.

6066. Compressed Air in the Foundry. Cutis W. Shields (The many uses to which compressed air can be advantageously applied in the foundry are set forth in this paper). Ir Age–May 14. 2400 w.

†6074. Modern Foundry Practice in Connection with Manufacture. John Morris (Machine moulding, and mixtures of iron found advantageous in practice are the topics chiefly touched upon in this paper). Engineers' Year Book–Univ of Minn. 2200 w.

†6078. Notes on Machine Designing John H. Barr (In this paper the engineering elements and the commercial elements that must be taken into account in designing machinery, are considered together and the necessary compromises between them). Engineers' Year Book–Univ of Minn. 1400 w.

†6088. Descriptive Geometry and Working Drawings. W. H. Kirchner (The importance of the study in constructive mechanics, and the different quadrant methods of projection, are the chief topics of discussion). Engineers' Year Book–Univ of Minn. 1400 w.

6161. Coiled Springs. E. T. Adams (General discussion of the practicability of a table of average strength and deflection that will be of service to practical men, with a diagram). Am Mach–May 21. 1300 w.

6162. A Fixture for Grinding Profile Cutters. A. L. de Leeuw (Illustrated description). Am Mach–May 21. 1200 w.

6163. Slipping Clutch for Electrically-Driven Punches and Shears (Illustrated description of a clutch which is claimed to overcome difficulties experienced with clutches previously employed). Am Mach–May 21. 900 w.

6166. Testing Lubricating Oils. W. E. Crane (Cheap device for this purpose described and illustrated). Am Mach-May 21. 500 w.

*6233. Frames for Blue Printing (Useful practical hints). Prac Eng–May 15. 800 w.

6275. Odd Belt Lacings. B. F. Fells (Twelve unusual varieties of lacing are illustrated and the method of making each described). Am Mach–May 28. 500 w.

6278. The Use of the Slide Rule. F. A. Halsey (The first part deals with general principles). Am Mach–May 28. Serial. 1st part. 1800 w.

6279. Inspection Tests. B. F. Spalding (An argument emphasizing the necessity of thorough inspection of work at the right stages, as an element of success in manufacturing). Am Mach–May 28. 2200 w.

6420. Twist Drill Making and Other Operations at New Bedford. M. (Illustrated description of plant, tools and processes). Am Mach–June 4. 4400 w.

Steam Engineering.

*5972. Circulation in Water-Tube Boilers. A. C. Elliott (An attempt to formulate mathematically the principles of boiler circulation). (Engng–May 1. Serial. 1st part. 2200 w.

*5976. The Production of Steam and Power. W. Stagg (Boilers of different types classified in order of efficiency, and the subjects of steam production and power production, with conditions of economy are discussed). Gas Wld–May 2. 3000 w.

6098.—$1.25. Temperature—Entropy Diagrams for Steam and Water. Louis M. Nulton (The graphic method applied to the calorimetric study of an engine, and the exchanges of heat taking place between the fluid and the internal walls of the cylinder). Jour Am Soc of Nav Engs–May. 3500 w.

6109. Loop Losses in Compound Engines. Charles M. Jones (A demonstration that looping between the cylinders of a multi-expansion engine not only involves a loss of power, but that the loop area is not a criterion of this loss. The true measure of the loss is also explained). Elec Engng–May. 1100 w.

6153. Steam Boilers: Their Equipment and Management. Albert A. Cary (Read before the National Electric Light Assn. Part first begins the discussion of what style of boiler is best adapted to the work). Elec Rev–May 20. Serial. 1st part. 1500 w.

6160. Piston Valves. W. H. Booth (First part describes and illustrates a continuous bodied piston valve and a provision for preserving the circularity). Am Mach–May 21. 1000 w.

*6238. Wegener's Powdered Fuel Boiler Furnace and Apparatus (Brief description and tabulated data of a test of the apparatus by Mr. Bryan Donkin). Eng, Lond–May 15. 1000 w.

6349. A Theory of the Injector. Myron G. Stolp (The action of the injector is found analogous to that of the condensing steam-pump. An interesting and instructive article). Mas St Fitter–May. 2000 w.

6361. Greene-Wheelock Vertical Compound Engine at the Atlantic Avenue Station of the Edison Illuminating Co., of Boston (Illustrated detailed description). Power–June. 2000 w.

6362. Steam Plant of the American Surety

Company's Building, Broadway, New York (Illustrated detailed description). Power-June. 1500 w.

6387. Special Forms of Engine Foundations. E. A. Merrill (Illustrated description of an engine foundation specially adapted for situations where the building foundation is carried to bed rock from which it is necessary to isolate the engine foundation). Am Elect'n-May. 600 w.

†6424. The Worthington Cooling Tower for the Continuous Use of Condensing Water. John H. Cooper (Illustrated description and discussion of advantages). Jour Fr Inst-June. 2500 w.

*6460. Compound Mill Engines (Illustrated detailed description). Engng-May 29. 1300 w.

Miscellany.

*5968. The Panhard-Levassor Road Motor (Illustrated detailed description). Engng-May 1. 2600 w.

*5969. The Latrobe Steel Works (An interesting illustrated general description). Engng-May 1. 1600 w.

*5970. Lock-Nuts and Nut-Locking Devices. E. H. G. Brewster (Paper read before the Civil and Mechanical Engineers' Society. The first part is a general discussion of the large number of patented lock-nut devices which have been placed before the public. The requirements (not few) of a perfect nut locking device and mention of attempts made to meet these requirements). Engng-May 1. Serial. 1st part. 3000 w.

*5973. Automatic Breech Mechanism for Quick-Firing Guns (Illustrated detailed description of a very ingenious device). Engng-May 1. 1400 w.

†6085. Railway Mechanical Engineering. H. Wade Hibbard (A plea for greater attention to locomotive mechanical engineering in our technical schools). Engineers' Year Book-Univ of Minn. 4300 w.

6093. Water Power in New England. James Francis (Abstract from a paper entitled "Power" read before the Washburn Engineering Society of the Worcester Polytechnic Institute. A masterly review of practice with turbine water wheels, emphasizing the fact that the effect of draft tubes is a subject that needs further research. Comparison of cost of steam and water is made, and increase in the use of turbines for power stations transmitting power by electricity is predicted). Eng Rec-May 16. 2200 w.

6097.—$1.25. Formulæ for the Strength of Seams, Stays and Braces for Cylindrical Boilers. A. B. Canaga (These formulæ are based upon the propositions that the thickness and lap of the shell sheets, the diameter and pitch of the rivets, should be so proportioned that the shell shall be on the point of tearing asunder between the rivets, just as the plate in front of the rivets and the rivets themselves, are about to give way by crushing. And that the tightness of the seam will be insured when the elements of the seams are proportioned for greatest strength to resist bursting pressure. The seams usual in marine cylindrical boilers are the ones considered. The subject is illustrated by diagrams). Jour Am Soc of Nav Engs-May. 2800 w.

6157. Compressed Air as Used for Power Purposes. Frederick C. Weber (Lecture delivered before the Engineering Society of Columbia College. The first part deals with the principal uses, production, compression and sources of loss). Compressed Air-May. 2000 w.

6209. Molding Machines and Their Field. Harris Tabor (General treatment of the subject and statement of advantages and limitations). Ir Tr Rev-May 21. 2500 w.

6211. Hydraulic Rotative Engines. Arthur Rigg (Paper read before the Soc. of Engs. The development of the modern rotative hydraulic engine is traced from the time of Bramah, up to date). Ind & Ir-May 8. Serial. 1st part. 4500 w.

*6260. Notes on Conveying-Belts and Their Use. Thomas Robins, Jr. (Describes experiments with various compositions of rubber for conveying belts, and then discusses the different ways of supporting such belts, with what the author regards as the best way). Col Guard-May 15. 3000 w.

*6294. The McKenna Process of Renewing Steel Rails. Robert W. Hunt (Lecture delivered before the students of Sibley College. The writer reviews the history of rails, and the changes that affected their service, with the methods used to overcome the difficulties, with explanation of the named process). Sibley Jour of Engng-May. 3800 w.

*6295. Test of Gas Engine Plant. Charles E. Barry (A description of the plant of the Danbury & Bethel Car and Electric Co of Danbury, Conn., with account of test). Sibley Jour of Engng-May. 3000 w.

*6296. Test of a Refrigerating Plant. E L. Spencer and A. W. Wyckoff (The machine tested is of the De La Vergne make and had been in operation less than one year. The plant is described, and test reported). Sib Jour of Engng-May. 1200 w.

*6297. Car and Line Tests on the Buffalo and Niagara Falls Electric Railway. H. O. Pond and H. P. Curtiss (Abstract from thesis in Mechanical Engineering. The test was divided into friction test, traction test, acceleration and electrical tests of car, etc). Sib Jour of Engng-May. 1000 w.

*6344. Recent Improvements in Coal-Handling Machinery. John D. Isaacs (Read before the Technical Society of the Pacific Coast. Illustrated description of improved apparatus for handling coal. Discussion follows). Jour of Assn of Engng Socs-April. 4000 w.

*6450. What Is An Invention? (An able editorial criticism of a widely copied paper by W. H. Smyth, originally printed in the *Mining and Scientific Press*, entitled "Invention: the Indefinable Requirement of the Patent Law"). Eng, Lond-May 29. 1500 w.

6455. Natural Gas and Its Use as a Fuel. Bert M. Seymour (Present practice in applying natural gas to heating furnaces in the arts and to generation of steam). Sta Eng-June. 1000 w.

*6456. Compressed Air Tramways (Describes the Serpollet system for the propulsion of cars on tramways). Engng-May 29. 3200 w.

MINING & METALLURGY

A Metallurgic Revolution.

Dr. Theo. B. Comstock, writing for the *Engineering and Mining Journal*, uses this title for a brief article upon another aspect of the changed conditions which are so ably reviewed by Dr. Chance in the June and July numbers of The Engineering Magazine, in his papers on "Recent Improvements in Gold Milling."

A few years ago, says Dr. Comstock, "once in a while a light demand would occur for rich concentrates, and very rarely would come a call for a carload or two of pyritous ores; but the free handling of auriferous sulphurets was out of the question at profitable rates. The smelters, which absorbed the whole product shipped from the mines, were but poorly provided with roasting facilities. This condition has now been so completely revolutionized that vast areas in Colorado, California, Arizona, and New Mexico are to-day marketing auriferous sulphids and other ores in quantity from mines hitherto abandoned and from below the water level in mines hitherto unprofitable within the water zone.

"In the vicinity of Prescott, Ariz., the pecuniary factor, as shown by results of shipments five years ago and now, has altered as much as $26 per ton in favor of the seller, in some instances. A part of this, to be sure, is the effect of reduced freight traffic, but a very large proportion is due to the lowering of the treatment charge for smelting and the credit given for iron in the ore in excess on a neutral basis.

"There are people to-day who object to investing in mines carrying pyritous ores simply because they are not informed regarding the metallurgic revolution which has given these materials a respectable standing in our ore markets. These constitute the great bulk of the product of central Arizona, as well as of other regions in the West, and many of the deposits are remarkably rich in gold. I do not think we are handling them all with adequate skill when we cling, as many do, to the old stamp-mill process, with fine concentration, although much of this practice may be justifiable with the surface ores, which carry free gold. Sooner or later the employment of coarse concentration, with chlorination or a similar process, must come to be the accepted doctrine for much of our local product, as in portions of California, although pyritic smelting may well play an important *rôle* in many instances.

"Those who imagine or pretend that the changed conditions are more favorable to the success of local custom reduction works, near the mines, are reasoning from false premises, or giving evidence of ignorance of metallurgic principles,—I mean business principles, practical business requirements. Copper matting, or, possibly, copper smelting, for ores carrying practically no gold or silver, might be judiciously operated at selected points, but rarely, as a custom plant, to as great advantage as in the hands of a mine-owner. If the revolution, now but begun, has any particular effect upon the success of local works, it must be constantly to diminish their profits in proportion as it gives advantages to the large corporations at the centers of trade, the labor, money, ore, and bullion markets, where costs are minimized and facilities vastly increased, to say nothing of the vantage gained by choice of ores and fluxes, with the means of enforcing low rates of freight and other concessions."

"No revolution in metallurgy can make a mine out of a tunnel or shaft, however much it may decrease the proportion of cost to income. But there are several ways in which a dollar may be justly claimed to have greater earning power than formerly, on account of this particular revolution. For one thing, it has caused unwonted competition among manufacturers of machinery. As a consequence, we have more and better and cheaper mining tools and appliances than before. Powder, used more economically, is lower in price, steel is better and less costly, skilled labor is more abundant and more skilled, and somewhat reduced in price. Provisions and other supplies are furnished in most mining camps much more reasonably than formerly. Ore is hauled by skilful teamsters at less cost, and in many other items the expense of mining and reducing ores has been very materially lessened within the last five years. When to all this is added the marked increase in marketable adaptability of ores of different grades and qualities, formerly outclassed or unprofitable, and the many abandoned mines which are now paying dividends from discarded dumps alone, we have a picture of the mining industry more tempting to investors than at any previous period; and careful investigation will show that it is yielding to business-like investment more returns than any other form of enterprise open to capital."

Dr. Comstock's remarks with regard to the small demand for the construction of "local custom reduction works" are interesting, in view of the rather indiscriminate appeal which has recently been made to capitalists to invest their funds in enterprises of this character.

Decadence of the British Iron Trade.

THE COLLIERY GUARDIAN prints a portion of a letter from Mr. B. H. Thwaite, C. E., from which the following extract is taken:

"To any one who has watched the growth of continental manufacturing industrial enterprise, the serious meaning of the following statistics in Mr. Jacks's paper, read before the recent meeting of the British Iron Trade Association, will not have come as a revelation:

THE WORLD'S PRODUCTION OF PIG IRON.

	1871.	1882.	1893.
Great Britain..	6,627,000	8,493,287	6,229,841
Germany......	1,278,000	3,469,719	4,700,000
Other countries.	3,878,000	9.358,693	11,709,502

PROPORTION OF THE WORLD'S OUTPUT SUPPLIED BY GREAT BRITAIN.

1871.	1882.	1893.
Per cent.	Per cent.	Per cent.
50	40	29

"The British output is practically stationary, whereas Germany has increased her output by 300 per cent., and the combined output of other countries has increased from 1871 to 1893 by 300 per cent.

"Serious as the signs of our industrial decadence undoubtedly are, they are the more irritating because our natural advantages are unrivalled, as the following sequence of interrogatories proves: (1) Where can we find a country possessing sites for industrial establishments, and at the same time so geographically situated as to be center of the two worlds? (2) Where is there a country with such a line of seaboard and with such harbors in proximity to deposits of the raw materials required to manufacture merchantable iron and steel? (3) In what country do we find in such extraordinarily appropriate association all the raw materials necessary for the production of merchantable iron? Every true answer to these questions will be the same. We have unique natural facilities, and this natural birthright in a race where we have so many paces to our good should compel us to try to utilize these advantages to the full. We obtain our ores, our coals, and our fluxes cheaper than any of our competitors, but, once the labor element is associated with their conversion into merchantable iron or steel, our deficiencies commence to assert themselves. English workmen were once the labor aristocrats of the world, and the title English-made was a character of the highest excellence. This was in the era of individual labor; English workmen had pride in their work, because their individual efforts and skill were preserved. The new order of industrial collectivism has meant the more or less complete destruction of individualism, and with it the pride of the individual Englishman in his work. The continental workman has been trained by years of comparative serfdom to value the money return for his labor, and he is able to make a mark or shilling purchase in the necessities of life twice that which an English workman can obtain for the same expenditure. So that he is paid on an average but 60 per cent. for the same output of work (labor-cost per ton of output); nevertheless, he manages to exist perhaps as comfortably and as well as the Englishman. This difference of 40 per cent. in labor costs and in the greater continuity of industrial peace (labor strikes are of rare occurrence) tends to destroy the intrinsic natural advantages possessed by the English employer in low cost of raw materials, and makes it possible for the German and Belgian manufacturer (handicapped as he is by nature both in the possession of metalliferous and the carbonaceous agents) to successfully compete with us in foreign markets. The cost of carriage of raw and manufactured materials again gives the continental competitor the advantage over us. The governments of France, Germany, and Belgium have never been so unwise as to allow the rail-carriage proprietors to destroy the water-carriage means of communication. This is what the British government has done. The canals have been suspended from operation by neglect, and, although there are some 3,000 miles of canal-ways in this country, probably only one-half their length is navigable. The railway companies bought them up, and have allowed them to fall into disuse. The fact is, the one big industrial question that is coming rapidly to the front is: Shall British iron, steel, and other heavy manufacturing industries be sacrificed on the altar of railway monopoly?"

It is risking little to say that Mr. Thwaite's conception of the cause of the loss of British supremacy will hardly appear adequate to a large number at least of his readers, and the answers, on this side of the water, to his triumphant questions will not be as unhesitatingly favorable to his argument as he assumes.

It is amusing, in view of the figures of the American iron trade, to notice how completely Mr. Thwaite ignores it as an individual factor, and sinks it in the miscellaneous total of "other countries." As a matter of fact the pig-iron production of the United States was, for 1871, 1,730,800 tons; for 1882, 4,698,790 tons; and, for 1893, 7,239,206 tons.

Accepting Mr. Thwaite's figures for the total output of the world (they agree fairly well with those of *The Mineral Industry* for 1893), we get the following

PROPORTION OF THE WORLD'S OUTPUT SUPPLIED BY AMERICA.

1871.	1882.	1893.
15%	22%	32%

The proportionate influence of natural advantages and artificial conditions in producing this increase is too deep an inquiry to institute here. No doubt our protectionist essayists and statesmen would insist that the infant industry had been most healthily and successfully stimulated by careful nursing.

The important question, after all, might be how much each country produced outside of its home consumption; but, if Mr. Thwaite is anxious to locate England's lost supremacy in total output, he might cast his eyes this way, and discover one of the "other countries" which, since 1871, has increased its output more than three hundred per cent., and in 1893 produced some fifteen per cent. more pig iron than Great Britain herself.

Production of Metal Bars by Extrusion.

MR. ALEXANDER DICK'S "squeezing or squirting patents," as they are termed in graphic, if somewhat homely, language, seem likely to form the basis of a new industrial process, the contemplation of which excites mixed feelings of respect for its importance, admiration for its simplicity, and wonder that no one has done it before.

As a matter of fact, the principle had long been applied, as everyone knows, in the manufacture of lead pipe and lead wire. The enlargement of the application needed only that adjustment of conditions to requirements which anyone might have made, but which it apparently remained for Mr. Dick actually to effect.

Lead flows under pressure, because it is plastic; to cause other metals to behave in a similar way required only that they should be brought into a similar state of plasticity through the influence on their molecular structure of the simple agency of heat.

Mr. Dick's process consists in placing the red-hot metal in a cylindrical pressure chamber, fitted at one end with a die. Upon application of pressure at the other end, the metal is forced through the die in a rod of section determined by the shape of the die-opening.

As frequently happens in the perfection of inventions, the greatest difficulties seem to have been encountered in determining the details. The most important was the construction of the containing cylinder, which, in the first experiments, was made of solid steel, bored out to the required diameter. It was found, however, that, even if previously heated in a coke fire, the strains on the cylinder walls from unequal heating and cooling, superadded to those caused by the heavy pressure on the contained metal, soon developed cracks which made the apparatus useless.

Success was ultimately attained by using a built-up cylinder, formed of a thin internal liner jacketed with successive alternating metal shells and interlayers of non-conducting material.

The size of the cylinder, and other conditions, vary, of course, with the size and nature of the charge to be pressed. In making small rods, the die may have several openings, forming as many rods at each operation. This practice is, indeed, actually installed.

So far, it is understood from Mr. Perry F. Nursey's paper before the Iron and Steel Institute, the process has been commercially installed at two or three English and continental works, and is being applied to "Delta metal, brass, aluminum, aluminum bronze, and other alloys and metals." He considers it "not outside the bounds of possibility" that it may be adapted to handling iron and steel.

It is not surprising to learn further that the process greatly improves the physical properties of metals subjected to it. "Some tests made at Woolwich Arsenal with Delta metal bars produced by extrusion show a tensile strength of 48 tons per square inch, with 32.5 per cent. elongation in two inches, against 38 tons per square inch tensile strength and 20 per cent. elongation of rolled bars of the same metal."

Mr. Dick seems to have developed an interesting and practical metallurgical improvement, with large possibilities of extension.

The Available Stores of Anthracite.

PROF. WILLIAMS'S article in this issue on the utilization of anthracite culm affords a startling revelation of the enormous and reckless waste which has attended mining operations in the past, and which has but recently begun to excite any uneasiness or meet any check.

Nature's stores appear so lavish, and man's appreciation of his huge consuming power is so inadequate, that the lesson of economy is never learned, except through experience, and, when learned, is immediately forgotten, or, at least, never applied by obvious analogy to a parallel series of conditions.

Probably the swiftest and sharpest, as well as most recent, example is natural gas. Seldom has the development based on discovery and expectation been so large, the waste so reckless, or the inevitable result so prompt.

The close relation to the fuel question has awakened a new solicitude regarding the sufficiency of other fuel supplies, and this lends a heightened interest to the elaborate data on the subject of anthracite coal prepared by the *Bond Record*, which have been in course of publication for some months and are enriched with maps and special diagrams. The author of the series is Mr. William Griffith, of Scranton.

In view of the great care with which the work seems to have been done, especial importance will attach to the estimate of the total anthracite tonnage supply of the future, which is placed at 5,073,786,750 tons. The figures, however, are "intentionally conservative." They are concerned with shipment coal only, and hence exclude local consumption. In the northern field all beds are ignored which will not yield 3 feet of clean coal, and in other fields all which will not yield 2¼ feet. Culm piles and pillars are also excluded, and the figures omit the Bernice coal-field in Sullivan county, estimated to contain ten to fifteen million tons of marketable coal.

It is interesting to compare these figures with former estimates quoted in the articles. Joseph S. Harris, in a *Forum* article (April, 1892), placed the total anthracite usable as fuel, including that in culm-piles and pillars, at 5,960,000,000 tons; the report of the Pennsylvania Coal Waste Commission for 1893, including thinner beds than those considered by Mr. Griffith, makes a "liberal estimate" of 6,898,000,000 tons.

Such figures mean little to most persons, and the *Bond Record* adds:

"It will perhaps help the reader to a better comprehension of the figures of our table to say that the future tonnage of the anthracite region, if prepared for market, would completely fill an ordinary city street, 60 feet in width, to a depth of 60 feet, or say to the tops of the fifth story windows, for a distance of 8,800 miles. On the basis of the shipments of 1895 we are exhausting this supply at the rate of about 81 miles per year, and, according to the record of the past 25 years, the consumption is increasing at the rate of over two additional miles per year. As previously stated, this does not include the tonnage from culm piles and other sources, from which a considerable supply will doubtless be obtained in the future; for, as certain sections cease to yield, further efforts will doubtless be made to re-work the abandoned mines. Considerable tonnage will thus be obtained, as well as from the thinner veins not included in our estimate."

"According to the summarized estimate, 109 years is the life of the anthracite industry, on the basis of shipments made in 1895. If we follow Mr. Joseph S. Harris, president of the Philadelphia & Reading Railroad Co., in assuming 60,000,000 tons as the limit of annual shipments, the supply would last about 84 years, and, at the average annual rate of increase from 1870 to 1895 (1,200,000 tons per annum), this limit would be reached in about ten years,—*i. e.*, in 1906."

It is not surprising, in view of modern tendencies, to learn that an output comparatively so limited has been subjected to efforts at control, but the completeness and the apportionment of the result will perhaps be surprising,—at least, interesting.

Here are the figures of shipment, allotment, and tonnage reserve.

	Percent. of shipment, 1895	Percent. allotment 1896.	Per cent. future supply controlled.
Del., Lacka. & Western R.R. Co.	13.16	13.35	6.55
Del. & Hudson Canal Co.	9.34	9.60	2.29
Erie & Wyoming Valley R. R. Co	3.75	4.00	1.82
Erie R. R. Co.	3.91	4.00	.77
N. Y., Ont. & Western Ry. Co.	3.06	3.10	.28
N. Y., Susque. & West. R. R. Co.	3.02	3.20	.54
Del., Susq. & Schuylk. R. R. Co.	4.11	3.50	1.38
Pennsylvania R. R. Co	10.59	11.40	6.24
Central R. R. of New Jersey	11.51	11.70	17.30
Lehigh Valley R. R. Co	15.81	15.65	16.87
Phila. & Reading R. R. Co	21.47	20.50	42.25
Uncontrolled tonnage		....	3.71
Total [see diagram on page 501]			100.00

"From this we see that the corporations named control, either directly, or indirectly through their sub-companies, 96.29 per cent. of the available tonnage of the future, and in about the following manner:

They own, by actual purchase or its equivalent	90.93%
They control by long-term contracts, say about	3.36%
They control by short-term contracts of various kinds, say	2.00%
	96.29%
Uncontrolled,—*i. e.*, remaining in private hands	3.71%
Total	100.00%

"The above figures show how completely the anthracite industry is under the control of the above corporations, and it must be evident that they are in a position to form a powerful combination, trust, or what you will, if they can only unite upon a policy and adhere to it."

The *Bond Record* naturally regards the question largely from the investors' standpoint of possible dividends.

To the general public, the exhaustion of the future resources will appear the larger question: the clear view of the end of one important fuel supply suggests grave dangers.

The answer may be found in some wonderful advance in economy, not only in mining, but in using coal, such as would result from the perfection of a process for direct production of electricity from the latent energy of carbon. Such a promise is held forth by Jacques's patent, discussed elsewhere in this number. Again, the answer may be as unexpected as the discovery of mineral oil, just about the time when the world was growing anxious over the approaching extinction of the sperm whale. It would be strange, indeed, if the "coal combine" should find its importance waning as rapidly as did that of the New Bedford whaler.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Min ing and Engineering Journals—See Introductory.

Metallurgy.

*5942. Recent Improvements in Gold Milling. H. M. Chance (Showing how gold-milling processes have been lowered in cost and increased in efficiency). Eng Mag–June. 3900 w.

*5959. Remarks on Iron and Steel Rolling Mills. John T. Brassington (Paper read before the West of Scotland Iron and Steel Institute. A general view of rolling mills used for iron and steel for the purpose of showing the progress that has been made in size and output in the last 20 or 30 years). Ir & St Trs Jour–April 25. Serial. 1st part. 1300 w.

5986. Furnace Construction and Fine Ores. Guy R. Johnson (A letter to the editor referring to Mr. F. E. Bachman's paper on the deposition of carbon in the Mesabi ores, etc., and making suggestions aiming to overcome difficulties mentioned in the named paper). Ir Tr Rev–May 7. 500 w.

*5988. Nickel Steel. William Beardmore (Read before the Inst. of Engineers and Shipbuilders in Scotland. Results of investigations with a view to proving that what can be done with carbon steel can be more advantageously accomplished with nickel steel). Ind & Ir–May 1. 1800 w.

*6011. The Manufacture of Wrought Iron (Historical account of the industry from the earliest records to the present). Ir & Coal Trs Rev–May 1. 3500 w.

*6012. Modern Blast-Furnace Practice and the Pig-Iron Manufacture of Different Countries. Presidential address of E. Windsor Richards before the Inst. of Mech. Engs. (An interesting record of the competitive circumstances of the leading iron-making countries of the world in reference to this branch of the iron trade, and supplying facts of value to all who are concerned in this industry). Ir & Coal Trs Rev–May 1. Serial. 1st part. 6500 w.

*6013. The Recovery of Ammonia in Coke Manufacture. From *Stahl und Eisen* (Investigations of noted scientists and their conclusions). Ir & Coal Trs Rev–May 1. 1000 w.

6062. Physical Tests and Chemistry of Cast Iron. W. J. Keep (Read at the first National Convention of Foundrymen. Directions for testing with 16 tables and 3 charts. The tables are taken from the records of the Committee on Tests and Methods of Testing of A. S. M. E.) Ir Tr Rev–May 14. 4800 w.

†6077. Some Experiments with Brom-Cyan. H. C. Cutter (Experiments made with the new solvent for gold showing that in some cases brom-cyan solution gives better results than simple potassium cyanide). Engineers' Year Book–Univ of Minn. 800 w.

*6105. The Production of Metallic Bars of Any Section by Extrusion at High Temperatures. Ill. Perry F. Nursey (Paper read before the Iron and Steel Inst. Descriptive of an ingenious metallurgical process, the invention of Mr. Alexander Dick, and considered to be of far-reaching importance). Eng, Lond–May 8. 2400 w.

*6135 The Ford and Moncur Hot-Blast Stove. Benjamin James Hall (Paper read before the Iron and Steel Inst. A description of the Ford and Moncur patent, which has given excellent results for 12 years). Col Guard–May 8. 1800 w.

6141. Comparative Tests of Nickel Iron Alloys. David H. Browne (The writer proposes to show, in practical units and figures which are readily comprehended and remembered, the effect which nickel has on the strength of wrought iron, cast iron and steel). Eng & Min Jour–May 16. 1200 w.

6142. The Volatilization of Silver in Chloridizing-Roasting. L. D. Godshall (A reply to the criticism of the late Mr. Stetefeldt). Eng & Min Jour–May 16. 2000 w.

6206. Quantitative Estimation of Tin. Cecil J. Brooks (A brief record of experiments made to ascertain the cause of the low results which are often obtained in the determination of tin). Eng & Min Jour–May 23. 600 w.

*6223. English and American Rolling Mills (Abstracts of two papers read before the British Inst. of Civ. Engs. I. American and English Methods of Manufacturing Steel Plates, was by Jeremiah Head. II. Four American Rolling Mills, by Samuel T. Wellman. Mr. Head's paper was a comparison of methods. The second paper describes four mills, typical of modern American practice). Engng–May 15. 1800 w.

*6249. Mond Producer Gas Applied to the Manufacture of Steel. John H. Darby (Read before the Iron and Steel Inst. As Dr. Ludwig Mond has explained his process for the manufacture of the gas, in an address some time ago, the writer confines himself to the improvements and the application of the gas to the manufacture of steel). Min Jour–May 16. Serial. 1st part. 2200 w.

*6256. The Chemical Composition and the Strength of Malleable Iron. A. Ledebur, in *Stahl und Eisen* (Review of two works by Baron Jüptner von Jonstorff on his investigations of this subject, with reference to the experiments of Mr. Webster of America). Ir & Coal Trs Rev–May 15. 1500 w.

*6257. The Iron Industry of Birmingham and Bessemer, U. S. A. Jeremiah Head (The facts and opinions of the writer, as presented, are the result of two visits to Alabama, and of information since obtained). Ir & Coal Trs Rev–May 15. 4200 w.

*6281. The Introduction of Standard Methods of Analysis. Baron Hanns Jüptner von Jonstorff (Abstract read before the British Iron and Steel Inst. A discussion of the subject, its difficulties and the important questions to be considered. A valuable paper of special interest to chemists in iron and steel works. It was followed by a discussion). Ir & St Trs Jour–May 16. 5800 w.

*6282. On the Rate of Diffusion of Carbon in Iron. Prof. Roberts-Austen (Abstract of paper read before the British Iron and Steel Inst. Facts of importance in relation to the question of the passage of sulphur and sulphides into the center of an ingot, especially the passage of solid carbon into solid iron). Ir & St Trs Jour–May 16. 2000 w.

*6283. Note on Mr. Howe's Researches on the Hardening of Steel. F. Osmond (Read before the British Iron and Steel Inst., with discussion. A comparative examination of manganese, nickel, and active carbon to see how the critical points and the essential physical properties may be correlated). Ir & St Trs Jour–May 16. 7200 w.

6290.—$1.50. The Condition of Steel in Bridge Pins. A. C. Cunningham (An account of the making of bridge pins and the necessity for special testing, with four tables of tests, with specifications submitted as being likely to procure as good bridge pins as can be had in common practice). Am Soc of Civ Engs–May. 2000 w.

*6346. The Diffusion of Metals. W. C. Roberts-Austen (A brief abstract of the "Bakerian Lecture" of the Royal Society, showing that diffusion can be measured in both molten and solid metals). Nature–May 21. 2500 w.

6369. A Metallurgic Revolution. Theo. B. Comstock (Mainly dealing with the increase in value of auriferous sulphurets, due to improved methods, &c). Eng & Min Jour–May 30. 1200 w.

6385. Cupolas and Cupola Practice up to Date. Edward Kirk (Prepared for the National Convention of Foundrymen, Phila. A review of the best practice in cupola melting, with much information on the subject). Ir Tr Rev–May 28. 2000 w.

*6478. A Sketch of a Modern Blast Furnace Stack. A. P. Gaines (Describes and discusses briefly the blast furnace stack only). Eng Assn of the South–April. 3400 w.

6485. Aluminum the Metal of the Future. From "The Wonders of Modern Mechanism" (In what its value lies and its uses, with a review of its properties). Prog of the Wld–June. 1500 w.

*6491. A Rare Metal. T. L. Phipson (The value of thorium and its light giving property—showing how a new industry has arisen from its discovery). Knowledge–June. 1500 w.

6492. Cost of Basic Open-Hearth Plants. From *Tin and Terne* (Refers only to such a basic open-hearth plant as would be appropriate as an adjunct to a tin plate plant. Estimate is given in which the writer endeavors to allow fully for all expenses). Ir Tr Rev–June 4. 1400 w.

Mining.

*5962. The Ballarat Gold Field (Account of the working of the mines, the researches seeming to favor the opinion that gold shoots will be found to have extended to greater depths than humanity will be able to follow). Aust Min Stand–March 19. Serial. 1st part. 1200 w.

*5987. Transmission of Power by Compressed Air at the North Star Mine, California. P. R. Robert (Read before the Inst. of Min. & Met. The first part is descriptive of the plant and its working). Min Jour–May 2. Serial. 1st part. 2800 w.

*5990. Sinking a New Shaft at the Colliery of the West Bohemian Company, Near Pilsen. K. Anton Weithofer (Description of general arrangements, sinking, masonry and ventilating of the "Bayer" shaft). Col Guard–May 1. 2200 w.

*5991. Honigmann's Method of Boring Mine Shafts. W. Schulz (Abstract of paper in *Glückauf*. A sinking tower is let down into a tubbed shaft, and the water pumped out, and mixed with loam or clay, is allowed to flow back into the shaft, the loam addition consolidating the shaft sides). Col Guard–May 1. 2000 w.

6023. Ontario as a Mining Country. A. P. Coleman (An enumeration of the minerals, metals, &c., found in Ontario, and their value, stating that petroleum gives the greatest aggregate return. The mines are many of them worthy the attention of capitalists). Can Eng–May. 4000 w.

*5992. A Theory in Mine Ventilation (An account of interesting experiences in mine ventilation in which certain anomalies in air flow, contrary to currently accepted theory, manifested themselves, and which have compelled the author to think it is time that colliery managers and engineers recognized that there are other factors in efficient ventilation than mere volume, and that the ventilating pressure shown by the water-gauge is not a record of the subtle gains, losses, restitutions and differential influences of the pressure *en route*). Col Guard–May 1. 2400 w.

†6079. Elements of Methods of Metal Mining, Based upon Lake Superior Practice. Ill. F. W. Denton (A description of the method or system of mining, the work of the removal of the deposit, and the considerations which should influence the establishment of a method of min-

ing). Engineers' Year Book–Univ of Minn. 6200 w.

*6133. Regulations as to Fiery Mines in the Loire Coalfield (Substance of the government regulations as to ventilation, lighting, and the use of explosives for fiery mines in the French department of La Loire, issued last Sept. on behalf of the Prefect). Col Guard–May 8. 2800 w.

*6139. Notes on Sinking Two Shafts by Poetsch's Freezing Process, at Ounaing, near Valenciennes, France. H. F. Olds (A paper read before the first students' meeting of the Inst. of Mining and Metallurgy. Descriptive of two shafts sunk by congelation by the Auzin Mining Co). Min Jour–May 9. 1000 w.

6143. Texas Coal-Fields. R. S. Weitzell (Brief description of the bituminous coal-fields). Eng & Min Jour–May 16. 500 w.

†6144. Outline Scheme for Mine Surveying. Edward B. Durham (Considers the location of stations, running underground traverse, shaft surveys, calculations and plots). Sch of Mines Quar–April. 4500 w.

*6250. Ancient Mining: With Especial Reference to that Carried on in Great Britain. A. Cooper Key (The author has endeavored to consolidate and condense all the facts he could obtain in regard to ancient mining, and to present them as clearly as was possible in the limit of a short paper. The first part treats of Egyptian surface-working and mining, mines in Asia, and Phœnician mining). Min Jour–May 16. 1200 w.

*6251. The Placer Gold Fields of Ecuador (An editorial account of the region with the prediction that the country is destined to add considerably to the world's output of gold). Min Jour–May 16. 1200 w.

†6252. The Coal Fields of Labuan (A short description of this island in the China seas and its coal field, of interest because of the important part it would play in any naval operations which Great Britain may undertake in the East). Ind Engng–April 18. 900 w.

*6259. Safety in Colliery Winding. C. M. Percy (Read at the meeting of the Manchester Geological Society. The writer presents, what in his opinion is a really good equipment, thus making accidents in mines, with colliery winding appliances, very nearly impossible). Col Guard–May 15. 3000 w.

*6261. New Arrangement for Putting Down Mine Shafts (From a communication by Friedrich Gerber to *Glückauf*. A contrivance, illustrated by engravings, is described which was designed to secure the greatest possible continuity in sinking shafts, and bringing up to the surface the stuff excavated, with any water encountered; rapid, easy and safe loading and unloading of the above, as well as of materials hung on to the skip, no trans-shipment being required; and high duty). Col Guard–May 15. 1700 w.

*6262. Probable Continuity of the Shropshire, South Staffordshire, and Forest of Wyre Coalfields. W. J. Clarke (Read before the Dudley and Midland Geological and Scientific Soc. at Coalbrookdale. Information concerning this region, explaining difficulties that do not seem likely to be overcome, hence the probabilities are not promising). Col Guard–May 15. 2500 w.

6289.—$1.50. A Water Power and Compressed Air Transmission Plant for the North Star Mining Company, Grass Valley, Cal. Ill. Arthur De Wint Foote (A concise description of the whole plant is first submitted, followed by the detailed presentation of its several parts, and finally the results obtained after careful tests during three months of actual working). Am Soc of Civ Engs–May. 6500 w.

6306. The Cyanide Process at the Mercur Mine. B. E. Janes (Extracts from a paper read before the students of the University of California. The first notable success with the cyanide process in America was made at the Mercur mine. The peculiar nature of the ore seems to be adapted to the cyanide process). Min & Sci Pr–May 23. 2400 w.

*6334. Annals of Coal Mining and the Coal Trade. Robert L. Galloway (The first part is a review of the history previous to 1066 A. D.). Col Guar–May 22. Serial. 1st part. 4400 w.

*6335. Constitution of the Southern Portion of the Valenciennes Coalfield. M. Chapuy (From a communication to the *Annales des Mines*. Fresh information as to measures in the south of the coalfield and a comparison of acquired facts with the various hypotheses put forward). Col Guard–May 22. 4600 w.

*6336. Mining in the Brown Coal District of North-west Bohemia and the Pilsen (Hard) Coal Field. Remy: *Zeitschrift für Berg, Hutten-und Salinenwesen* (Describes the beds, character of coal, development of the industry, workings, &c). Col Guard–May 22. 3000 w.

6347. The Wyoming Petroleum Oil Fields. Wilbur C. Knight (An account of the early history and development, oil districts, nature of the oils, geology, &c). Am Mfr & Ir Wld–May 29. 1600 w.

*6386. The Coal Deposits of the North-West Territories of Canada. W. Henry (Describing particularly the lignite deposit of the Souris Valley). Min Jour–May 23. 2500 w.

6400. Exploring with the Govt. Diamond Drill. Thomas W. Gibson (The important aid to mining rendered by the diamond drill, a description of the instrument and practice in operating, are the subject of part first). Can Min Jour–May. Serial. 1st part. 2200 w.

*6428. The Oquirrh Mountains or the Mercur Mining District, Utah (An epitome of the Geological Survey's report of the region by Messrs. Emmons and Spurr, with notes and comments by Prof. Arthur Lakes). Col Eng–June. 5400 w.

*6429. The Vulcan Explosion. David Griffiths (A description of the mine and the conditions existing therein. The work of rescue and an investigation of the probable cause of the disaster). Col Eng–June. 6000 w.

*6473. The Dayton Mine Explosion. F. P. Clute (A brief description of the mine and existing conditions, and of the disastrous explosion of Dec. 20, 1895, with the cause). Eng Assn of the South-April. 4500 w.

*6474. Handling Coal by Gravity at Whitwell, Tenn. Tyler Calhoun (A description of the mines and manner of handling the coal. From 800 to 1000 tons per day is the output). Eng Assn of the South-April. 3400 w.

*6476. Coal Handling Plant at Pikeville, Tenn. J. J. Ormsbee (Illustrated description of a plant designed to handle the coal carefully and clean it thoroughly). Eng Assn of the South -April. 1300 w.

*6479. Gold Mining in Georgia. B. M. Hall (This brief paper is intended to call attention to some sources of information, and to point out a few peculiarities of the industry). Eng Assn of the South-April. 1600 w.

*6481. The Sapphire and Ruby Mines of South-Eastern Siam. From the London *Times* (Historical account of discovery of the mines, with interesting information, description, etc). Min Jour-May 30. 3000 w.

*6482. Notes on the South Wales Coalfield. M. E. (Description of measures, method of working, ventilation, hauling, pumping and coking). Col Guard-May 29. 1200 w.

*6483. Report of Her Majesty's Inspectors of Explosives for 1895 (The twentieth annual report. Reviews the modifications of the law since the Act came into operation, the growth of the trade, and the additions to the list of authorized explosives). Col Guard-May 29. 1800 w.

6495. The Cedar Valley Quarry. Samuel Calvin (Illustrated description of a quarry in Cedar Co., Ia., with its machinery and manner of working). Eng & Min Jour-June 6. 1400 w.

Miscellany.

*5963. Terrible Colliery Catastrophe in New Zealand (Brief account of accident in the Brunner coal mine in the Greymouth district of New Zealand in which 60 miners were killed. Illustration of the scene of the disaster). Aust Min Stand-April 2. 1000 w.

*6010. The Iron Trade of Great Britain Half-a-Century Ago. From Vol. 109 *Quarterly Review* (Historical review of the iron trade, tracing the progress and causes that have influenced it). Ir & Coal Trs Rev-May 1. 2500 w.

6036. Some Notes on the Occurrence of Uraninite in Colorado. Richard Pearce (Read before the Colorado Scientific Society in Denver. History of its first discovery in Aug. 1871, and of the amount and value realized). Min Ind & Rev-May 7. 900 w.

†6086. Ore Deposits in Minnesota. Arthur H. Elftman (A brief sketch of the present status of development of iron, manganese, gold and silver, nickel and cobalt, and copper). Engineers' Year Book-Univ of Minn. 900 w.

*6134. On the Treatment of New Zealand Magnetic Iron-sands. E. Metcalf Smith (Paper read before the Iron and Steel Inst. A description of the extensive deposit, analysis and treatment). Col Guard-May 8. 800 w.

6140. The Mineral Production of California in 1895 (Facts taken from the statement of the California State Mining Bureau with editorial comments). Eng & Min Jour-May 16. 1000 w.

6149. Early Use of Anthracite Coal. William Griffith in the *Bond Record* (An interesting account of the discovery and use of anthracite, dating back to 1762). Bul of Am Ir & St Assn -May 20. 1100 w.

6207. Mineral Resources of the Judith Mountains, Montana. Walter Harvey Weed (Geology of the region, with some account of the mines that have been producers, and give promise of bright future. The distance from railroads makes the working of low grade ores impossible, and a large amount of ore already developed is practically lying idle for want of proper treatment). Eng & Min Jour-May 23. 1700 w.

6348. "The Invention of the Bessemer Process." Jos. D. Weeks (An answer to the criticisms on the address of the writer in which he claimed that the honor of the invention belonged to William Kelly). Am Mfr & Ir Wld-May 29. 2500 w.

6364. William Kelly's Own Account of His Invention of the Pneumatic Process (An Account prepared by Mr. Kelly in 1884 for incorporation in the "History of the Manufacture of Iron in All Ages"). Bul of the Am Ir & St Assn-June 1. 1500 w.

6401. The Treatment of Timber for Use in Mines. Robert Martin (Read before the Mining Inst. of Scotland. Treatment to render the wood durable and incombustible). Can Min Jour-May. 2500 w.

6402. Gold and Silver Ores of the Slocan, B. C. J. C. Gwillam in *Can. Record of Science* (Brief account of the geology, with description of the minerals and metals found). Can Min Jour-May. 1000 w.

*6430. The Metamorphism of Coal—How It Occurs and What Causes It. H. Bolton (The conversion of bituminous coal into anthracite and graphite, and the conversion of carbonaceous matter into diamond). Col Eng-June. 5500 w.

*6431. Classification of Bituminous Coals. Baird Halberstadt (What constitutes good steam, gas, smithing and coking coals). Col Eng-June. 2100 w.

*6432. Coke Oven Construction. R. M. Atwater (Its effect on coke, with special reference to Semet-Solvay ovens. The object of the paper is to offer methods of coking the Pittsburg coal, which will enlarge the boundaries of the standard coking coal to all the Pittsburg coal fields that bear coal of standard chemical composition. Read before the Soc. of Engs. of Western Penna). Col Eng-June. 2500 w.

*6438. The Gold Fields of Alaska. Robert Stein (Largely descriptive of the country and means of access to the gold fields). Rev of Rev-June. 3000 w.

6494. The Opening Up of Our Big Goldfield. Dan DeQuille (The condition of gold mining in this country, and the value of the mines, with reference to foreign mines). Eng & Min Jour-June 6. 2400 w.

MUNICIPAL ENGINEERING

City Sanitation.

In a lecture delivered at the Sanitary Institute, an abstract of which is printed in *The Sanitary Record* (London, May 8), Mr. Charles Mason, member of the Institute of Civil Engineers, and surveyor, St. Martin-in-the-Fields, places asphalt at the head of all paving materials for city streets as regards sanitation. Therefore, all courts and alleys, where the ordinary street traffic need not be considered, should be paved with asphalt. Whatever is of an unsanitary nature (or liable to become so on exposure to atmospheric influences), falling upon the surface of an asphalt pavement, remains on the surface, and may be easily and thoroughly removed by washing with water.

The trapping of street gulleys—or "gutters," as we call them in American cities —is also advocated. With the exception of their outlets, they should be made water-tight. Upon the imperviousness of surfaces in streets, courts, and alleys the maintenance of perfect sanitary conditions much depends. A good form of gulley is the stone-ware, trapped, coffee-pot gulley, which is easily cleaned out, and which prevents the entrance of mud into sewers. A new form of gulley known as the "Crosta" gulley is commended, and has been largely adopted in London and other English towns. It has a double trap, and protects the sewers from the entrance of anything deleterious.

As to collection and disposal of refuse, method, first and always, should be the watchword. Every detail should be brought under an inexorable rule. Those districts of London that have a regular routine system—a system that cannot be departed from under any excuse—are the cleanest and best kept.

In London there are practically two systems for the removal of snow,—*viz.*, (1) by sweeping, and carting away; (2) by sprinkling salt, and washing the resultant liquid off the road. Clean snow can be tipped into the river or sewers; it is, however, seldom that the latter course is adopted, as only the main sewers have sufficient volume and velocity to take away the snow as quickly as it is deposited in the manholes. The use of salt is often a necessary evil, and should be resorted to only when circumstances render it almost impossible to deal with snow by carting. Everything in connection with a fall of snow requires a perfect system in management, with all in readiness for use at a moment's notice.

Street-watering is a necessity in the summer months as a means of keeping down the dust, which accumulates in greater or less degree upon all classes of pavement. In many English seaside towns salt water is used for street-watering, which is in itself far more effective than fresh water. It lasts for a much longer time, one load of sea water being equal to three loads of fresh. An objection has been raised that sea water is detrimental to the road surfaces, but it has not been proved to be founded on facts, and may be considered as groundless. That sea water lasts three times as long as fresh water is a strong argument in its favor.

Instead of making large receptacles for refuse and removing it at long intervals, modern sanitation takes the opposite course. Small receptacles and frequent removal is now the approved practice. Disposal of human excreta by what is known as the conservancy system the lecturer regards as adapted only to small towns. The removal of these matters by water has proved safer, more convenient, and more economical in large cities.

Touching cremation of garbage, the objection that it destroys valuable material that might otherwise be saved is answered by the statement that the heat produced, properly applied to generation of power, more than offsets the alleged loss. The system of carting all refuse to the nearest waste ground, or filling up disused brick yards in the neighborhood of towns, is condemned as directly opposed to all ideas of modern sanitation. It is to be regretted that many towns still carry on this rough-and-ready way of getting rid of their refuse. The disposal of refuse by cremation has for some considerable time occupied the attention of sanitary authorities, and the system of erecting refuse-destructors is now being adopted by a great many municipalities.

Contamination of Wells.

AT a recent meeting of the American Water Works Association, Dr. J. N. Hurty secretary of the Indiana State board of health, in reading a paper entitled "The Water Supply of Indianapolis" (reported in *Paving and Municipal Engineering* (June), said that well-water in that vicinity had been badly contaminated from surface drainage, even to the second water level. "Two weeks after a great fire, where millions of gallons of water were thrown upon burning wholesale houses, wells drawing their supply from the second water level tasted of sugar, salt, bacon, and stale fish, located a distance of several hundred feet from where the fire occurred. The public water-supply of Indianapolis, obtained from White river and nine artesian wells, had been notably free from impurities until quite recently, when analyses had shown pollution with fecal bacteria. This had been traced to the dumping of offal by vault-cleaners in the river, nine miles above Indianapolis, which was at once stopped."

A representative of the water company maintained that the impurities named by Dr. Hurty were not the menace to health that might be supposed. In his remarks he said:

"Fecal bacteria are found under some circumstances in practically all surface-waters. E. O. Jordan has found in spring water, which was beyond any suspicion of contamination, bacteria which in form, size, growth on gelatine, potato, etc., were indistinguishable from bacillus coli communis. Dr. Theobald Smith says: 'I am not inclined to doubt the presence of an occasional individual of b. c. c. in any water which reaches the surface of the earth, owing to the presence of the latter in all natural manures. Burri suggests that the detection of fecal bacteria in a large quantity of water may lead to the condemnation of really good water. The wide distribution of the colon group has led some writers to regard b. c. c. of little value as a symptom of fecal contamination.' At present the tendency seems to be in the other direction, and more attention is being paid to processes designed to reveal its presence. Schardinger is inclined to look upon the presence of gas-producing forms of all kinds in water as indicative of pollution. This is true, if by pollution we mean filth of any kind, for the movement towards pollution, especially of surface-water, seems to begin with the appearance of gas-producers, which steadily increase in numbers with the amount of pollution."

In investigations of water-pollution some samples from sources practically unpolluted showed no fecal bacteria. Other samples from apparently as good sources contained four or five such bacteria in the cubic centimeter. These bacteria get into surface water from animal feces, and from these sources, unless the quantity is large, no danger is to be apprehended. When the sources of the bacteria are human fecal matter, there may be grave danger. It is, therefore, unsafe to condemn surface water on account of the presence of fecal bacteria alone. Their quantity and the sources from which they probably come must also be considered.

Asphalt Pavements Laid upon Natural Soil.

THE practicability or impracticability of using asphalt for paving directly upon compacted soil, and without the usual foundation, on streets where the traffic is light, will, according to *The Investor* (Los Angeles, Cal.), soon be demonstrated by an experiment in Los Angeles. In discussing this method *The Investor* states some of the local effects upon property in that city resulting from the use of granite pavements instead of the clean and noiseless asphalt. It says:

"Advocates—mostly interested ones, of course—have from time to time appeared, each recommending his favorite material. Granite blocks, vitrified brick, porphyry, macadam, asphaltum, bituminous rock, eucalyptus cedar, and other wooden blocks, have each found strong advocates. In some cases the argument of cheapness has prevailed, to the after-regret of property owners, who have learned that the first cost is sometimes the least before they get through with paving. One pays for a pavement in more ways than one, and the payment is not by any means finished when the contractor has received his due. At the time that the streets of Los Angeles were first paved, the ring wanted to introduce granite blocks, and it secured, by the way of compromise, the contract for a certain portion of the business streets. In those very portions, without any exception, the rents have since declined over fifty per cent., and the property owners are organizing to have the blocks sunk two inches deep and covered with asphaltum. In the streets where the noiseless, clean pavement was laid, business has gained and rents have risen.

"While property owners in Los Angeles can well afford to lay an expensive pavement with concrete foundation upon the business streets, and feel that they have made an excellent investment, in localities where the frontage is much less valuable the endeavor is to obtain a cheaper substitute.

"At Riverside, a mile and a quarter of city streets are being paved with the well-known Alcatraz asphalt, which is laid to the depth of two inches upon the natural soil previously excavated and well-rolled The simplicity and cheapness of this method of street-paving are admirable, but could only be successful in those places where the soil is firm and hard. In San Diego a similar plan was tried four years ago, when ten blocks were paved in this manner. It has proved so successful that ten blocks more are now to be paved in the same way.

"No pavement, no matter what surface-material is used, can be better than its foundation,—a dictum that applies to concrete as well as earth. It is not so much the traffic that injures a pavement as it is inexperience in laying, and neglect, and want of cleanliness after it is down, the blind permissions given to tear it up for sewer and other pipe connections, and the ignorance and indifference attending its repair."

It is admitted that such a pavement can succeed only in special situations; but, wherever practicable, the saving of the cost of a concrete foundation is an item worth considering. Also, in tearing up pavements for pipe work, the cost of opening the pavement and of repairing it again will be less. Municipalities will do well, however, to go slowly in the adoption of this method of paving. Preliminary experiments with small surfaces should be made, to indicate whether the soil is sufficiently compactible to warrant laying asphalt directly upon it.

Comparative Cost of Filtration with and without Alum.

IN a paper read before the American Water Works Association, and printed in *Paving and Municipal Engineering* for June, Mr. Allen Hazen, while asserting that results are of the first importance in filtration for water-supply, and that cost is secondary, still considers the question of cost as one that cannot be disregarded. In concluding his paper, he said:

"The reversal of the order of these two points is a continual and ever-recurring source of disaster the world over. A process which fails to accomplish its ends is dear at any price, and a process capable of yielding an abundance of pure and wholesome water is of such inestimable value as to be cheap, whatever it costs; and I am confident that our American cities are abundantly able to pay for the best process of filtration obtainable, whatever that may be, and that they should, and eventually will, insist upon having it, regardless of any trifling savings which may be made by the installation of inadequate or imperfect filters."

Mr. Hazen stated that the efficiency of mechanical filtration at high rates, as also of sand filtration, depends upon the addition of alum to the water before filtration. But the use of alum is practically inadmissible with some of the soft waters of New England and other parts of the country, which contain very small quantities of alkaline carbonates; and he considers that the cost of alum is another and serious objection to its use.

"It has sometimes been said that the quantity of alum to be used need not exceed a grain per gallon, and even lower limits have often been mentioned. As a matter of fact, however, I believe that it must be admitted that, both with waters highly charged with peaty matters, and with the muddy waters of our great rivers, a complete and satisfactory clarification and purification cannot be obtained with any such quantity of alum, and that from two to five grains per gallon are often required to secure a thoroughly satisfactory effluent at the rates of filtration commonly employed with such filters. A grain of alum in itself is certainly a very small quantity, but, when applied to each of many million gallons of water, the aggregate is very large, and at 2 cents per pound for alum, the cost of this quantity is $2.85 per million gallons,—a sum largely in excess of the entire cost of operating sand filters. When, in addition, the labor, power, and other expenses connected with the operation of mechanical filters are taken into account, it seems reasonably certain that the cost of operation per million gallons is far above the cost of operating sand filters.

"A great deal of ingenuity has been bestowed upon the construction of incubators to take the place of hens in chicken-raising. The advantages of the novel procedure are many and obvious, but I have yet to hear of an apparatus that will lay eggs, or that will hatch them in less than the three weeks that all well-bred hens require. Of course, I would not intimate for a moment that the safe rate of filtration is limited with a corresponding precision, but I do wish to say that we should have very adequate grounds for doing so before breaking away from abundant and conclusive European practice in the pursuit of methods for shortening and simplifying the process, particularly in view of the enormous importance of the thoroughness of the work, and the fact that inadequate results are not always promptly recognized, and great damage may be done before the injury is realized."

The Automatic Gas Sales Meters.

WHEN first introduced, these machines were supposed to be—and are even now called—automatic; but, according to *The Gas Engineer* (May 11), this class of consumer requires an enormous amount of looking after, and, although the meter is a splendid invention, it cannot, at present, be considered "automatic." The machinery for closing the valve after the consumption of so small a quantity as twenty-five feet appears still to be fraught with difficulties. There is nothing for it but the most rigid system of periodical inspection. A recent case is cited where a man went into an empty house. Not knowing whether there was gas or not, he placed a penny into the meter and lit the gas; thinking that, when his pennyworth of gas was consumed, the supply would be automatically turned off, he left the house, and also left the gas burning. This was careless. Many days after, an employee of the gas company passed, and to his surprise saw a light burning in the empty house. It is added that the very small margin allowed in the increased price charged will not warrant such losses.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Municipal Engineering in the American, English, and British Colonial Engineering and Municipal Journals—See Introductory.

Gas Supply.

5964. The Determination of a Light Unit. D. W. Murphy (Description of construction and use of an instrument devised by Prof. Lummer and Dr. Kurlbaum of the Physikalisebe Reichsanstalt, called the balometer and based upon the light emitted by one square centimeter of platinum kept at constant temperature. This seems an important innovation). Am Gas Lgt Jour–May 11. 2500 w.

5965. Diagrammatic Outlining of Gas Sales on Fuel and Illuminating Account (The method is illustrated by actual diagrams with explanatory text). Am Gas Lgt Jour–May 11. 300 w.

*5977. Some Experiences in Incandescent Lighting for Workshops, Sheds and Open Spaces. E. C. Riley (A short sketch of experiences in actual practice, adapting the Welsbach incandescent burners to requirements indicated in the title). Gas Wld–May 2. 2800 w.

*5978. How to Minimize Bad Debts. J. H. Penney (A discussion of sound business methods as applied to the business of manufacturing gas). Gas Wld–May 2. 3400 w.

6070. Commercial Value of Acetylene Gas as an Illuminant. T. A. Ferguson (Extract from a paper read before the National Electric Light Assn. An estimate of the minimum cost of electric lighting, leads the author to the conclusion that acetylene is not likely to prove a successful rival either to the incandescent gas light, or the electric light). Eng News–May 14. 2000 w.

*6092. Elusive Leakages from Main and Service Pipes. H. Tobey (Paper read before the North of England Assn. of Gas Managers. Experience with gas leaking into a sewer pipe. Discussion). Gas Wld–May 9. 5400 w.

6224. A Discussion of Certain Recent Data on the Cost of Acetylene and Calcium Carbide. W. H. Birchmore (Review of the report of experts sent by *Progressive Age* to investigate the calcium carbide, in which appears to be implied a disingenuous intention on the part of those in interest toward the public, and the accuracy of the figures given by the committee are questioned as not representing average conditions). Am Gas Lgt Jour–May 25. 3400 w.

*6225. Nine Years Ago and Now. William Foulis (Inaugural address on the recent progress in the manufacture of gas). Gas Wld–May 16. 5500 w.

*6226. Notes on Residuals. Charles Hunt (Paper read before the Incorporated Inst. of Gas Engineers. Economies possible in the treatment of residuals and other interesting details concerning these products, with discussion). Gas Wld–May 16. 6400 w.

*6227. On the Efficiency of the London Argand at Different Rates of Gas Consumption, with Special Reference to its Use as a Gas Testing Burner. Lewis T. Wright (Paper read before the Incorporated Inst. of Gas Engineers. Disputes the statement, in King's Treatise on Coal Gas, that the maximum illumination of this burner is reached under all circumstances just as the lamp is about to smoke, and submits the action of this burner to a critical study. With discussion). Gas Wld–May 16. 7800 w.

6353. A Few Words on Naphthaline. John Gimper (Dissents from the opinion that the formation of naphthaline is caused by temperature changes, and attributes it to the presence of water. Discussion). Am Gas Lgt Jour–June 1. 2000 w.

6357. The Future of the Gas Business of America. M. S. Greenough (A retrospect and a forecast). Am Gas Lgt Jour–June 1. 8300 w.

6358. Wrinkle Department at the Meeting of the Western Gas Association (Results of experiences, opinions, methods, and other practical information make up this paper, which is edited by a member of the association). Am Gas Lgt Jour–June 1. 6800 w.

6359. Practical Use of Acetylene. W. W. Goodwin (The employment of acetylene as an enricher is viewed favorably and the conclusions of Prof. Vivian B. Lewes on the subject are adversely criticised). Am Gas Lgt Jour–June 1. 2700 w.

6360. One Year's Experience with Gas in the Metropolis of Texas. W. A. McGoldrick (An interesting record with discussion). Am Gas Lgt Jour–June 1. 2700 w.

*6378. Incandescent Gas Lighting. V. B. Lewes (An exceedingly interesting and valuable paper largely historical, but also ably treating the scientific and practical sides of the subject. With discussion). Gas Wld–May 23. 12500 w.

*6379. The Measurement of Gas in Relation to Temperature. George Livesey (The effect of temperature upon gas metering and the need of some way of ascertaining how much a record of measurement may be vitiated thereby is the burden of the paper). Gas Wld–May 23. 1600 w.

*6380. The Application of the Expansion of Fluids to the Correct Measurement of Gas Passing Through Meters. W. W. Fiddes (Deals with the unaccounted for gas, resulting from temperature effects upon the action of meters. With discussion). Gas Wld–May 23. 6400 w.

Sewerage.

*5989. Sewage Purification (An exceedingly well prepared article dealing broadly with the subject and presenting illustrations of the important English sewage filtration works at Huddersfield and Melton Mowbray). Ind & Ir –May 1. 3000 w.

6069. Tables and Diagrams for Facilitating the Computation of Estimates for Sewerage Work. S. M. Swaab (A set of tables and diagrams whose object is to facilitate computation of estimates for sewerage work, with inset of diagrams). Eng News–May 14. 700 w.

6203. The Sewerage of Melbourne (Interesting historical and descriptive account). Eng Rec–May 23. 3500 w.

6415. Cement Pipes with Metal Skeleton (Illustrated description, translated from *La Nature*). Brick–June. 300 w.

6440. The Sewage Disposal Works of Natick Mass. (Illustrated detailed description). Eng News–June 4. 900 w.

Streets and Pavements.

*6411. Kinds of Pavement in American Cities (Tabulated statement of the kinds and extent of each kind of pavement used in some sixty-five cities in the United States and Canada). Pav & Mun Engng–June. 200 w.

6416. Brick Paving Statistics. George W. Kummer (Answer to a circular of inquiry. First part contains answers from Akron, O., Albany N. Y., and Altoona, Pa). Brick–June. 1500 w

6419. The Improvement of the North River Water Front, New York City (Illustrated detailed description). Sci Am–June 6. 1300 w.

Water Supply.

5975. St. Catharines, Ont., Water Works (Illustrated general description). Fire & Water–May 9. Serial. 1st part. 1500 w.

†6087. Foundations for a Power House. George J. Loy (Describes means and methods employed for meeting unexpected difficulties in placing the foundations, arising from inability to keep the excavation clear of water. A final resort to sheet piling enabled the excavation to be completed and the foundation was built upon bearing piles). Engineers' Year Book–Univ of Minn. 1000 w.

6091. Norfolk, Va., Water Works (Illustrated general description). Fire & Water–May 16. Serial. 1st part. 700 w.

6094. The Chain of Rocks Pumping Station, St. Louis (Illustrated detailed description). Eng Rec–May 16. 1700 w.

*6136. The Thirlmere Works for the Water Supply of Manchester. G. H. Hill (Read before the Inst. of Civ. Engs. Abstract. General description). Col Guard–May 8. 1000 w.

*6137. The Vyrnwy Works for the Water Supply of Liverpool. G. F. Deacon (Abstract of paper read before the Inst. of Civ. Engs. Descriptive). Col Guard–May 8. 800 w.

6182. The Jewell Mechanical Water Filter Plant at Wilkesbarre, Pa. (Very full illustrated description of this system of filtration, and of the plant). Eng News–May 21. 4400 w.

6183. How Meter Records Are Kept at Battle Creek, Mich. (Description of method and its merits, with a sample meter table). Eng News–May 21. 400 w.

6184. Extension of a Covered Water-Works Reservoir at Vienna (Trans. from the "Journal of the Austrian Soc. of Engs. & Archs. Interesting illustrated description). Eng News–May 21. 500 w.

6185. The Water Supply System of Ogden, Utah. W. P. Hardesty (Illustrated description of present system prefaced by a brief description of the old system, now suspended). Eng News–May 21. 2000 w.

6186. Typhoid Fever and Water Supply in 66 American and Foreign Cities (Abstract and review of an address by John W. Hill, before the faculty and students of the University of Illinois, comprising an array of statistics). Eng News–May 21. 1500 w.

6188. Tests of the Tightness of a Vitrified Earthenware Water Conduit. Dabney H. Maury, Jr. (Abstracted from a paper read at the annual convention of the Illinois Soc. of Engs. & Survs. Presents tabulated results). Eng News–May 21. 1600 w.

6277. Uses and Advantages of a Public Supply of Compressed Air. Frank Richards (The use of compressed air for generating needed pressure in a water distributing system, in lieu of the present stand pipe or elevated tank is advocated). Am Mach–May 28. 1100 w.

6316. Lynn, Mass.—Its Water Supply, Water Works, and Pumping Engines (Illustrated description). Fire & Water–May 30. 3500 w.

6318. Some Recent Installations of Power Pumps in Small Water-Works Pumping Plants (Illustrated descriptions of water-works pumps, driven by gasoline engines). Eng News–May 28. 1800 w.

†6363. Cincinnati Water Supply and Typhoid Fever (Report of committee at the Nov. meeting of the Cincinnati Academy of Medicine). San–May. 2400 w.

†6409. Standard Prisms in Water Analysis and the Valuation of Color in Potable Waters. Albert R. Leeds (Account of attempts to substitute for the hollow wedges containing colored fluids used in nesslerizing, wedges of colored glass). Jour Am Chem Soc–June. 2300 w.

*6412. Animal and Vegetable Growths Affecting Water Supplies. Albert R. Leeds (Report of Chairman of a special committee of the American Water Works' Assn). Pav & Mun Engng–June. 1400 w.

*6414. Filtration of Public Water Supplies. Allen Hazen (The possibilities of purification of water supply by this method are greater than have hitherto been generally supposed. The conditions for effective filtration are stated and defects in practice are pointed out). Pav & Mun Engng–June. 4500 w.

6441. Does Pure Water Pay? (Money value of pure water). Eng News–June 4. 1200 w.

*6464. The Bacterio-Chemical Examination of Polluted Waters. W. E. Adeney (Results of the latest researches). Engng–May 29. Serial. 1st part. 4000 w.

6467. Submerged Water Main at Columbus, Ga. (Illustrated description). Eng Rec–June 6. 500 w.

6468. The Queen Lane Pumping Station (Illustrated detailed description). Eng Rec–June 6. 1200 w.

†6501. Gutta-Percha Water Pipes. J. H. Morrison (An account of the use of these pipes, their advantages and disadvantages). Ind Rub Wld–June 10. 1700 w.

Miscellany.

6072. The Transportation of Goods in Towns and Cities (Editorial considering the problem of the cheaper transportation of goods through city streets, pointing out the fact that this work is at present done in an inefficient and extravagant manner, whereas it might, by a systematic organization, be conducted at a small part of its present cost). Eng News–May 14. 2500 w.

*6089. Scavenging-Disposal of Refuse. Charles Mason (Lecture delivered at the Sanitary Institute. Systems of collecting as well as final disposal are briefly considered, and the filling of city lots with refuse is deprecated as opposed to sanitary principles). San Rec–May 8. 1700 w.

*6410 Qualifications for Municipal Engineers. Charles Carroll Brown (A plea for a more thorough education). Pav & Mun Engng–June. 2300 w.

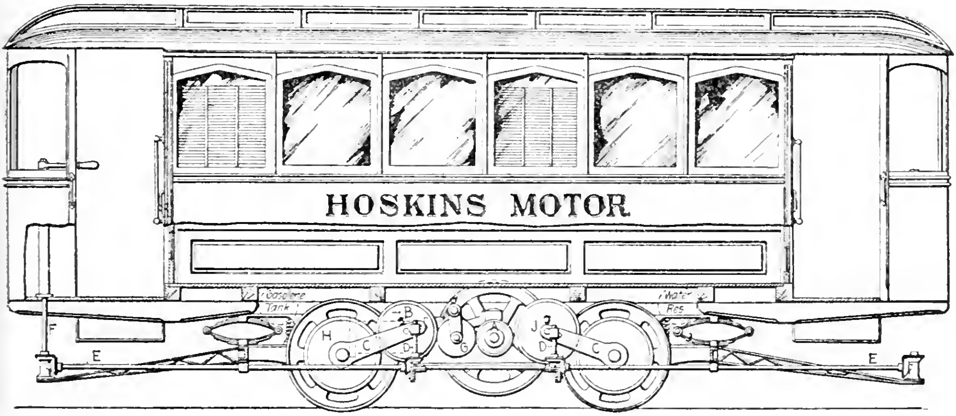
RAILROADING

Articles of interest to railroad men will also be found in the departments of Civil Engineering, Electricity, and Mechanical Engineering.

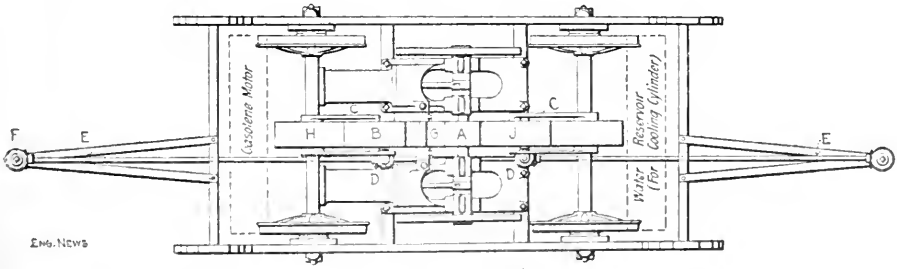
The Hoskins Gasoline Motor Car.

In our November and February issues we gave some details of gas traction as applied to English and continental street railways. America comes forward with several improvements upon these systems, under the name of the Hoskins motor, which is thus described by the *Engineering News* (March 12); "As will be seen, is developed than would be the case with a single engine of the same dimensions. The cranks are in the same plane.

"At the center of the crank shaft there is a friction pulley, A, 12 in. in diameter and 8-in. face. A loose friction pulley, B, with an 8-in. face, is hung on the frame, C, which in turn swings on the axle of the driving-wheel, H. The frame, C, is actu-



Sectional Side Elevation.



Plan of Frame and Machinery.

THE HOSKINS GASOLINE MOTOR CAR FOR STREET RAILWAYS.

the motor is carried underneath the car, and, together with the mechanism for transmitting the power, is closed in so as to be hid entirely from view. Two engines are used, both coupled to a transverse shaft, carrying at each outer end a 40-in. diameter fly wheel. These serve to give a steady motion and to overcome the inertia of starting. It is claimed that by this use of two engines more than twice the power ated by the screw, D, by means of the gears and shafts, E and F, the latter shaft being controlled by the motorman. The pulley, B, bears against a fixed pulley on the driving-wheel, H. Between pulleys B and A is a swinging-pulley, G. Now, if shaft E is revolved so that the screw, D, pulls down the pulley, B, connection is established between the pulley, A, and the pulley, H, by means of the intermediate pulleys, G and B, and the car moves ahead. As the shaft, E, is revolved so as to pull down the pulley, B, it also acts to push up the pulley, J, by which the car is run backward ; thus the revolution of the shaft, F, in one direction drives the car ahead, and its revolution in another direction drives it backward. Of course it will be understood that the crank shaft and pulley, A, revolve continuously when the car is in operation, simply running idle when power is not being used to drive the car."

"The gasoline is carried in a steel cylinder, tested by a pressure of 2,000 lbs. per sq. in., from which it is admitted to the engine cylinders, vaporized and exploded by an electric spark, from a four-cell battery located under the car seats.

"To start the engines to operating, a crank is operated by the end driving-shaft so as to cause the necessary explosions. The cooling water is piped from the water tank, no pump being used."

This motor street car is being tested on the Wayne avenue and Fifth street railway, of Dayton, Ohio, but no results are yet available.

A Compound Locomotive in Suburban Service.

It is rather remarkable, in view of the rapid development of the use of the compound locomotive, that there has been comparatively little publication of exact information with regard to the comparative results obtained from the new and the older types, under similar conditions. The figures below, copied from the *Railroad Gazette*, have, therefore, considerable interest, and would have more if the railroad official making the test had not been, as the *Gazette* regretfully says, "too modest to have his name or that of his company mentioned."

"Both the engines were built at the shops of the railroad company, and are identical in every particular, save in the front end. The compound device was furnished by the Richmond Locomotive Works, but was not attached or supervised by them. In other words, the railroad company simply bought a pair of cylinders from the Richmond Locomotive Works, as they would have bought any other furnishing of a locomotive.

"An interesting feature of the statement is its bearing on the question as to whether or not a compound is suitable for suburban service. It would seem that in this case, in the 24 trips, the compound made 494 stops, and reduced speed to less than three miles per hour 148 times, and must have picked up train and got under way with great ease, as it actually spent less time on the road with train and in running than the simple.

"The conditions were so much alike with the two engines that they must be accepted as the same, although it is manifest that the train was light for such heavy engines ; which was against the compound as it is especially adapted for hard service. The steam pressure was also against the compound, being lower than the simple, whereas the reverse is the usual practice ; and for 10 trips the compound heated the train.

"The compound saved 11,570 pounds of coal, or 20 per cent., which will not be appreciably affected by the slightly heavier train of the simple engine. The pounds of coal per engine-mile show the same percentage in favor of the compound. The coal per car-mile only shows about 14 per cent. saving, owing to the lighter load of the compound.

COMPARATIVE WORK OF SUBURBAN ENGINES.

Kind of engine.	Richmond Compound.	Simple.
Number of trips made........	24	24
Average steam pressure.....	154.1 lbs.	156.5 lbs.
Total weight of water evaporated......................	273,386 "	318,771 "
Total weight of coal consumed......................	46,630 "	58,200 "
Temperature of feed water..	61° F.	62° F.
Weight of water evaporated per pound of coal......	5.86 lbs.	5.47 lbs.
Average number of cars hauled......................	6.07	6.53
Car miles......................	3,352	3,611
Engine-miles with train.....	552	552
" " light...........	102	102
Total engine-miles...........	654	654
Pounds coal per car mile.....	13.9 lbs.	16.117 lbs.
" " " engine-mile..	71.3 "	88.99 "
Number of hours under steam......................	142 hours.	144 hrs., 30 min.
Number of hours on road with train..................	31 hrs, 9½ min.	32 " 3 "
Number of hours actual running........................	27 " 8¾ "	27 " 43¾ "
Number of hours on road with light engine...	8 " 44	7 " 40 "
Number of trips steam heat was in use..................	10	none
Total number of stops made.	494	516
Times speed reduced to less than 3 miles per hour......	118	122
Weather report..............	2 days clear, 2 days clouded, 2 days rain	2 days clear, 4 days clouded

"The compound has been continually in service, day in and day out, since it was built three months ago."

The English Railway Clearing-House.

THE English railway clearing-house is no doubt an outgrowth of conditions essentially different from those prevailing on this side of the water, but the principle is capable of wide adaptation, and an organization analogous in scope, but modified as to detail, would seem to be directly in line with modern American railroad tendencies.

The day of association for mutual advantage and joint economy has fully dawned, and it is a little strange that the newly-recognized principles have not yet found application in so manifestly appropriate a direction as this.

The workings of the English system were fully described by Dr. William Taussig before the Commercial Club of St. Louis in an admirable paper, from which large extracts have been printed in the *Railroad Gazette*. A brief summary of the principal points is given in the quotations below :

"The salient features of the organization are :

"*First.* It has nothing to do with the fixing of rates.

"*Second.* It undertakes only the division and settlement of the revenue derived from freight and passengers which pass over more than one line.

"*Third.* It has nothing to do with local traffic.

"*Fourth.* Each line determines its own local rates. Where there is no agreement between connecting lines as to rates on joint traffic, the clearing-house collects the sum of the local rates. If disputes arise, it makes no distribution of amounts collected, but holds them until the parties agree among themselves, or agree to submit the dispute to the arbitration committee of the clearing-house. If so submitted, the decision is final.

"*Fifth.* It pays out only balances found to be due to each road upon monthly settlements.

"*Sixth.* It keeps control, through its own officers and employees, of all movements of all the rolling-stock belonging to one company over the lines of another, notes their mileage, and distributes the charges arising therefrom.

"*Seventh.* It attends to the tracing aud recovering of all lost packages in freight or passenger trains, and to the settlement of these losses if not recovered, and determines the responsibility, or proportion thereof, of each line which has carried them.

"*Eighth.* Besides collecting and distributing monthly revenues arising from the carrying of freight and passengers over connecting lines, it supervises and controls the general and postal parcel department, which is similar to our express business. Settlements of revenues arising from the parcel department are made only every six months.

"It will be seen from the above that the railway clearing-house deals not merely with accounts, but with almost all questions that can arise between the different railway companies. The chief departments into which it is organized are the following : (1) the department for freight traffic ; (2) department of passenger traffic, of which the parcel department is a branch ; (3) department for the tracing of cars of one line running over another line, and for recording the mileage thereof ; and (4) department for lost articles.

"*First.* The department for freight traffic. The main work of this department is the monthly division of charges for the transportation of all classes of freight which pass over more than one railway. For the purpose of division the department receives from every station a report of the whole of the goods dispatched every day, and also of the goods received ; and the first task of the department, when all these have come in, is to group them together, so that shipments and receipts may be easily compared with one another. If differences appear, they are sent to the respective stations, and no settlement is made until the difference is cleared up. The report of the two stations having been verified, the report of the sending station, which generally collects the entire amount, is transferred to what is called the 'settlement form,' and the total amount of freight divided between the railways concerned.

"*Second.* The passenger department, which undertakes to settle the accounts of all interchanging traffic, animate and inanimate, conveyed by passenger trains.

"*Third.* The mileage department. The principal work of this department is the recording of the numbers and the tracing of each individual vehicle from the time it leaves until it returns home, the careful noting of the exact route traveled, and the time occupied in running the respective distances. It deals with the rolling-stock of every company whenever it passes from the parent line, watches and records its progress and return, and apportions the charges accruing from its use.

"*Fourth.* The loss and damage department is carried on on a similar line with the others, but one is astounded, when reading the reports, at the rapidity with which lost goods are traced, forgotten passenger parcels recovered and returned, and how the actual total of losses is reduced to a minimum through the admirable system adopted.

"It remains only to show, in a general way, how the system operates. For purposes of division, the clearing-house receives from every station on every line:

"1. A monthly report of the entire freight dispatched at the station, where from, the initial of the car and the car number, what charges, if any, attached thereto for drayage, loading, etc., whether the freight is deliverable to consignee at the station or at his premises, and whether charges are prepaid or collectible.

"2. A monthly report of each ticket sold, the number thereof, the initial and terminal point, the class, amount received, and the lines over which ticketed.

"3. At the receiving station the same kind of report is made of goods received, which must tally precisely with the report of goods forwarded. All passenger tickets collected by conductors on trains are sent to the clearing-house, there assorted and compared with the report of the selling agent, and, unless the reports of the selling agent correspond with the tickets received, or unless the report of freight received corresponds with the report of freight forwarded, the clearing-house at once sets about to trace inaccuracies.

"4. All companies, parties to the clearing system, are required to give to the clearing-house security for the due payment of clearing-house balances to such amount and in such shape as the superintending committee may order.

"5. The bankers of the clearing-house are supplied with the names of the companies parties to the clearing system, and are instructed to make no payment to any railway company not included in the list.

"There are innumerable provisions in the rules relating to division of receipts, of expenses, payment of balances, etc., and the above is simply intended to give an outline of the system in general.

"The total gross railway receipts in the United Kingdom in 1894 amounted to £84,310,831, of which £30,000,000, or about 37 per cent., passed through the clearing-house in settlements. These figures show best the enormous task of which it relieves its members, the railways."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Railroad and Engineering Journals—See Introductory.

*5550. The Cost of Railway Working (American figures for maintenance of way and equipment, annually for six years, are given as object lessons in economy, and the English situation compared). Ir & Coal Trs Rev–April 10. 1100 w.

*5551. The Snowdon Mountain Railway Accident (Account of the accident at the opening of the line). Trans–April 10. 1000 w.

*5553. The "Crawl to the South" (Contains some statistics of punctuality of trains on the principal English railroads having a London terminus, interesting in comparison with U. S. practice). Trans–April 10. 900 w.

*5554. Notes on Light Railways Abroad: Their Permanent Way and Rolling Stock (The first number deals with Belgian light railways, especially the construction and cost of permanent way and the problem of transhipment to standard gauge roads). Eng, Lond–April 10. Serial. 1st part. 6000 w.

*5558. Permanent Way. J. C. (A discussion of the loss of power due to rail deflection under the car wheels, with incidental commendation of the American passenger coach). Eng, Lond–April 10. 700 w.

*5559. The Accident on the Snowdon Railway (An account of the accident, with map of the line and illustrations from photographs of the wreck). Eng, Lond–April 10. 600 w.

*5592. The "Dunalastair" (Brief illustrated description of new express locomotive for the Caledonian Railway). Loc Engng–May. 500 w.

*5593. Old Philadelphia and Reading Locomotives (Notes and photographs of some old type locomotives). Loc Engng–May. 400 w.

*5594. Testing Slide Valves on Purdue University Locomotive (Describing the joint investigations of the University and the Master Mechanics' Committee, and criticising the failure of railroad corporations to assist in such work). Loc Engng–May. 900 w.

*5595. Distortion of Flue Sheets (Account of some tests indicating that the sectional expander causes great distortion, while the roller expander is free from any such defect). Loc Engng–May. 300 w.

*5596. Handy Air Lift (Illustrating a useful substitute for the block and tackle, for changing stacks and loading wheels). Loc Engng–May. 60 w.

*5597. Accident on the Great Northern Railway of England) Brief account of the accident, with photographs of the track and the wreck). Loc Engng–May. 200 w.

*5598. The Original Extension Front (Letter from A. M. Waitt, master car builder of the L S. & M. S. railroad, describing and illustrating his original spark arresting device and its early reception). Loc Engng–May. 850 w.

*5599. Advantage of Station Platforms (Arguing for station platforms on a level with car platforms, on the grounds of time saving and increased comfort of passengers). Loc Engng–May. 450 w.

*5600. A Device for Turning Worn Crank Pins (Description and illustration of an interesting device for truing up pins while in the wheel). Loc Engng–May. 200 w.

*5601. Graphics of Truck Arch Bars (The importance of proper designing, exhibited by designs showing the stresses in correctly and incorrectly proportioned arches. The subject is urged upon the attention of the M. C. B. Association). Loc Engng–May. 1100 w.

*5602. Roller for Car Axle Journals (Description of a tool for finishing journals, which is claimed to be almost a specific for hot boxes). Loc Engng–May. 250 w.

*5603. Some Fitchburg Kinks (Description of some useful devices used at the Fitchburg R. R. car-shops). Loc Engng–May. 400 w.

*5604 Shop Kinks at Valley Falls. O. H. R. (Interesting hints of useful shop practice and tools from the N. Y., N. H. & H. R. R). Loc Engng–May. 900 w.

*5605. Locomotive Details—Boston & Maine Railroad. O. H. R. (The details of which dimension drawings are given, are the rocking grate, oil cup for eccentric strap, brick arch and exhaust damper). Loc Engng–May. 450 w.

*5606. Central of Georgia Railroad Air-Brake Instruction Plant. W. W. Elfe (A condensed description with photograph). Loc Engng–May. 250 w.

*5607. Solution of Conger's Problem. C. B. Conger (Account of experiment showing the possibility of leaving the leakage groove uncovered after several reductions). Loc Engng–May. 300 w.

*5608. Does High Steam Pressure Increase the Danger of Boiler Explosions? (Editorial arguing that faulty inspection and not high pressure is the dangerous element). Loc Engng–May. 1400 w.

*5609. Wear of Tires Affected by Form of Rail Head (Extracts from a paper by Prof. P. H. Dudley, being a review of experience on the N. Y. C. R. R. with different patterns, the conclusion being highly favorable to the broad-head). Loc Engng–May. 900 w.

5610. Prospects for Railway Construction in 1896 (A summary of recent conditions, and of lines on which construction has begun or is promised). Ry Age–April 25. 700 w.

5611. The Shipper and the Law (From the circular of the Kansas City transportation bureau calling attention to the liability of shippers under evasions of the inter state commerce law). Ry Age–April 25. 500 w.

5612. Chicago's Railways (The number of roads entering the world's greatest railway center. A correction of the commonly quoted figures and a graphic diagram enumerating the existing lines). Ry Age–April 25. 800 w.

5613. Compressed Air Locomotives (General description and photographs of those in use on cotton wharves of New Orleans & Western R. R). Ry Age–April 25. 400 w.

5614. Increase of Heating Surface in Locomotives. C. W. Whitney (Communication urging the great economy of fuel to be expected from the use of the Servé internally ribbed tube). Ry Rev–April 25. 2500 w.

5615. Syracuse Station—N. Y. C. & H. R. R. R. Bradford L. Gilbert (Description, sectional drawing and plan of section, trainshed and tracks). Ry Rev–April 25. 1800 w.

5616. Liquid Fuel Burning.—Holden System (Photograph and description of liquid fuel burning locomotive on Great Eastern Railway, England). Ry Rev-April 25. 400 w.

5617. Steel Underframes for Freight Cars. D. L. Barnes (Contributed to the discussion on large freight cars at the meeting of the N. Y. R. R. Club. A prediction as to the limited agreement likely to be reached upon questions of construction, and the general agreement as to shape sof roller sections). Ry Rev–April 25. 800 w.

5618. Piston Travel of Air Brakes (Editorial reviewing the conclusions of Air Brakemen's Convention). Ry Rev–April 25. 1100 w.

5619. Ribbed Tubes for Locomotives (Editorial review of European practice and experience). Ry Rev–April 25. 1600 w.

5621. Air Compressors on the Santa Fé Ry. (A list of tools operated by air at the shops of this road). Ry Rev–April 25. 400 w.

5627. The Work of the Texas State Railway Commission (Editorial review of the work as set forth in the last report of the Texas Commission, approving the position as economically and politically correct, and stating that the work that has been done could be profitably studied by other States. They have attempted to base railway rates upon the cost of service). Eng News–April 23. 1500 w.

†5638. The Working of Automatic Brakes on Railways in India (Some notes on the progress of equipment and accident percentages of trains). Ind Engng–March 21. 800 w.

5681. The Destructive Action of Locomotive Driving Wheels (A statement of the evils of overbalancing, and suggestion of means for their reduction). Sci Am–May 2. 1200 w.

*5702. Coaling Station at Wabash.—Cleveland, Cincinnati, Chicago & St. Louis Railway (A description, illustrated by half tones, plans, and sectional drawings, showing the conveyer system for handling both coal and ashes). Am Eng & R R Jour–May. 1200 w.

*5703. Ten-Wheeled Locomotive—New York, Chicago & St. Louis Railway (Description of construction, with dimensions, and illustrated by sectional drawings of locomotive-boiler and details of link motion). Am Eng & R R Jour–May. 1600 w.

*5704. Locomotive Grates (A discussion of the nature of combustion and the effects upon it of the environment of the fire). Am Eng & R R Jour–May. 2500 w.

*5705. Hopper Gondola Car of 60,000 Pounds Capacity—Central Railroad of New Jersey (A brief description of some details of design, with drawings of the car, pocket castings and draft-rigging). Am Eng & R R Jour–May. 500 w.

*5706. Locomotive Boiler with Mason-Work Firebox. A. Socher (Translated from the *Organ für die Fortschritte des Eisenbahnwesens*, describing the construction and service experience and indicating the special advantages to be expected). Am Eng & R R Jour–May. 1800 w.

†5709. The System of the Staten Island Electric Railroad Company (A fully illustrated detailed description of the system, power house, roadbed and overhead construction and terminals). St Ry Jour–May. 3500 w.

†5710. Studies in Economic Practice:—St. Paul—Minneapolis. C. B. Fairchild (The first paper is devoted to operating expenses, receipts, maintenance, discipline and shop practice). St Ry Jour–May. Serial. 1st part. 3000 w.

†5711. Comparative Wheel Record (A tabulated comparison of five makes of wheel under severe service. Payment for wheels on a mileage record basis is recommended). St Ry Jour–May. 400 w.

†5712. Safety Switches. John A. Beeler (Communication describing and illustrating a device used in Denver with great satisfaction and economy). St Ry Jour–May. 600 w.

†5713. Insulation of Underground Cables. E. J. Spencer (Comment on a former article: the communication sharply criticises paper and fiber insulation). St Ry Jour–May. 1000 w.

†5714. Freight, Mail, Express and Baggage Service (A compilation of the experience of 45 roads touching the profit of such service, with editorial review). St Ry Jour–May. 3900 w.

†5715. The Law of Negligence, with Some Statistics (A review of John Brooks Leavitt's work compiling cases, codifying the law and classifying decisions. Some interesting data are abstracted). St Ry Jour–May. 3000 w.

†5716. Electric Conduit Construction in Washington (Description, with illustrations of some points in the Metropolitan R. R. Co.'s practice, especially with reference to the construction of insulators). St Ry Jour–May. 1300 w.

†5717. High Speed Line Between Washington and Mount Vernon (A brief account of construction of way, equipment and power house). St Ry Jour–May. 700 w.

†5718. Novel Seashore Electric Railway (An English seaside resort railway which runs on deeply submerged tracks is described and illustrated). St Ry Jour–May. 600 w.

†5719. The Recording Wattmeter in Railway Practice. Caryl D. Haskins (A description of the Thomson recording wattmeter and exposition of the value of a meter in street railway work). St Ry Jour–May. 1900 w.

†5720. A Résumé of the Opposite Joint Discussion. James A. Emery (Suggesting a compromise by very slightly breaking joints). St Ry Jour–May. 800 w.

†5721. Signals on Electric Railways (A discussion of methods for protecting crossings and blocks between turnouts, and for emergency communication with power station) St Ry Jour–May. 2400 w.

*5793. The Enlargement of Liverpool-Street Station, Graat Eastern Railway (The article is chiefly devoted to description of design and construction of a railway bridge. It is interesting as illustrating the solution of difficult problems attendant on enlarging railroad facilities in the heart of a city). Eng, Lond–April 24. 3300 w.

*5795. Compound Express Engine, Great Southern and Western Railway (Description and dimensions with drawing of change valve. No accurate data of performance or economy). Eng, Lond–April 24. 500 w.

*5798. The Railway Zone Tariff System in Russia (Gives details of the system, and tabulation of former and existing (reduced) fares. A large increase of travel reported since the reduction, and favorable predictions made for the future of Russian railways). Eng, Lond–April 24. 1000 w.

5806. Types of High-Speed Locomotives (Editorial discussion with diagram illustrating latest American and English types and a prediction as to probable development). Ry Mas Mech–May. 900 w.

5807. An Approaching Problem in Knuckle

Breakages. Knuckle (Communication suggesting the loosening of breakages at the link and pin hole by making the inside and outside surfaces of the knuckles convex, thus allowing a rocking motion). Ry Mas Mech–May. 1400 w.

5808. The Draft Gear Question (Communication, with plans showing present and proposed construction, the improvement consisting in bringing the line of draft and buffing strains to the center of the sills, instead of several inches below as at present). Ry Mas Mech–May. 1700 w.

5809. Painting a Locomotive in Ten Days. A. Ashmun Kelly (A review of an old discussion in the Master Car Painters' Assn. Several plans are given, and a symposium of opinion upon results). Ry Mas Mech–May. 1600 w.

5811. The Northwestern and the Union Elevated Railroads of Chicago (The first number describes the projection of the route, difficulties encountered, standard structure adopted, and gives descriptions and fine illustrations of general construction, and many special details). R R Gaz–May 1. Serial. 1st part. 2800 w.

5812. The Baltimore and Ohio Equipment Contracts (A brief but quite complete summary of the contracts to be let for various types of engines and cars, and an abstract of specifications for each). R R Gaz–May 1. 1200 w.

5813. The Air-Brake Men's Association (Concluding account of the Boston meeting, containing committee reports on maintenance of freight and passenger brakes, air-brake signals and main reservoir and connections, with topical discussions of various minor points). R R Gaz–May 1. 6500 w.

5814. The Latest Information about Car Lighting (Editorial comment, with abstracts, directing attention to the report of Profs. Chandler and Denton to the Lehigh Valley R. R. The report is highly favorable to the Pintsch lamp and gas). R R Gaz–May 1. 1400 w.

5815. Concerning Specifications (Editorial, questioning the economy of specifying individual makes for component parts in car construction, exemplified by illustrations from correspondence and practice. Discussion is suggested). R R Gaz–May 1. 1600 w.

5831. Signal Department Standards—Pennsylvania Lines West of Pittsburg (A review of the pamphlet recently issued by the company. The general principles of signalling are fully given, signal standards illustrated by diagram and note made of recent changes of specifications of construction, and special points in the practice of these lines). Ry Rev–May 2. 1400 w.

5832. An Automatic Air Brake Recorder (Mr. O. G. R. Parker's paper before the Northwest Railway Club, describing a continuous disc pressure recorder, attachable at any point on the train, as a check on the engine runner). Ry Rev–May 2. 1200 w.

5833. Some Convenient Pneumatic Appliances (These appliances for railroad shops, quite fully explained by illustrations, are a mud ring riveter, steam pipe ring chuck, crown bar bolt-facer, and painter for painting freight cars). Ry Rev–May 2. 800 w.

5834. Necessary Railroad Legislation (Recommendation of the Illinois Railroad and Warehouse Commission that legislative enactment should be passed, restraining unnecessary and destructive new roads. Text and editorial comment). Ry Rev–May 2. 1600 w.

*5859. The Railways of Japan (An excellent review of the history, present status, and the conditions affecting development, topographical, geographical, meteorological, seismic and political. Comment is made upon the growth of American influence, and English manufacturers urged to increase their representation). Trans–April 24. 3000 w.

*5860. The Tramways of the United Kingdom (Statistical tables devoted to mileage, capital investments, equipment, power and operating receipts and expenditures). Trans–April 24. 350 w.

5903. The Railway up the Jungfrau (A brief description with illustrations. The road will be operated by electricity, developed from the Lauterbrunnen falls ; it will be about eight miles in length, largely in tunnel ; the ascent of the cone will be completed by an electric elevator, running in a shaft bored in the rock). Sci Am Sup–May 9. 500 w.

5907. Ditching Car ; St. Louis Southwestern Ry. (Describing and illustrating a portable device for maintaining railroad ditches or lowering track. The machinery is operated by compressed air and is said to ditch and dress embankments on one side of the track, for 1½ or 2 miles per day). Eng News–May 7. 1500 w.

5908. Railway Bridges of Short Span. F. W. Wilson (Calls attention to the fact that short-span bridges are much more numerous than long span and equally disastrous in collapse ; describes and illustrates rail floor, longitudinal trough and special design bridges up to 16-ft. clear span). Eng News–May 7. 1600 w.

5929. Why do Rails Break? A. R. V. Dormus (From a paper read before the Austrian Soc. of Civ. Engs. Condensed from the *Zeitschrift des Oest, Ing. and Arch. Vereins*, by Julius Meyer. The paper goes into an extended discussion of chemical, physical and etching tests, urging the importance of the last named. The great differences in strength are attributed to segregations in the ingots, and suggestion is made that main track rails be selected from the lower ⅔ of rolled beams only). R R Gaz–May 8. 2400 w.

5930. Cast Iron Railroad Bridges in England (The article gives statistics, taken from a recent Blue Book, and is an interesting exhibit of the extensive use of cast iron in English bridges). R R Gaz–May 8. 1000 w.

5931. The Results of a Broken Rail (An editorial discussion of the St. Neots (England) accident, and of heavy weights on engine drivers, with some results of chemical and physical tests of broken rail). R R Gaz–May 8. 1600 w.

*5938. The Fruits of Fraudulent Railroad Management. J. Selwin Tait (Showing the source of distrust in United States corporations, and the legislation necessary to remove the same). Eng Mag–June. 4300 w.

5994. Uniformity in Storehouse Stock (Extracts from a paper by S. F. Forbes before the Northwest Railway Club, recommending adoption of uniform material on railways, with editorial). Ry Rev–May 9. 2000 w.

5995. European Electric Railway Statistics (Statistics of mileage, power, equipment and construction types. From *L'Industrie Electrique*). Ry Rev–May 9. 500 w.

5996. Body Bolster, 70000-lb. Car—Northern Pacific Railway (Description of construction with detail drawings). Ry Rev–May 9. 800 w.

5997. Mr. Justice Harlan's Dissenting Opinion in the Import Rate Case (An abstract. The Justice holds that the import rate is a discrimination against the native, putting him at the mercy of foreign combinations). Ry Rev–May 9. 800 w.

5998. Coal Hoppers on Standard Tenders—A. T. & S. F. Ry (Description and drawing of a substitute for the rack and boards). Ry Rev–May 9. 200 w.

6000. Statistics—Lake Shore & Michigan Southern Railway Company—Twenty-sixth Annual Report (The statistics are of freight and passenger traffic, earnings and expenses annually for twenty-five years, and are used to point an editorial in favor of absolute maintenance or material advance of rates). Ry Rev–May 9. 1200 w.

6002. Third Rail Supports—Lake Street Elevated Railroad (Description with drawings of truck attachment and photograph of insulator. The insulation is said to be unusually good). Ry Rev–May 9. 700 w.

6003. Power to Change Rates of Fare (Correction of mis-reported Chicago decision. It is stated that the right to fix rates of fare must be exercised at the time of granting franchise). Ry Age–May 9. 600 w.

6004. The Successful Passenger Man. George H. Daniels (States the five requisites to be knowledge of the line, industry, courtesy, promptness and honesty, and discusses each separately). Ry Age–May 9. 2000 w.

6005. A Broken Rail Accident on an English Railway (An account of the St. Neot's accident, condensed from the *Railway Engineer*. Describes the physical features of the accident in detail, with drawings of the broken rail). Ry Age–May 9. 1300 w.

6006. Relations of Railway Employés to the Public (Extract from an Ill. Cent. R. R. circular with comment by Mr. Harahan on the rule enjoining employés to report at once anything they may notice detrimental to the company's business, and to strive to accommodate the public). Ry Age–May 9. 800 w.

6007. Some Recent Coupler Tests (Record of drop tests conducted under R. R. supervision, with specifications adopted to govern acceptance of couplers). Ry Age–May 9. 200 w.

*6008. Railway Development in Rhodesia (A brief report of a conversation with the contractors, giving some facts about progress and opinions as to the political significance of the work). Trans–May 1. 1500 w.

6033. The Chamounix Railway. Translated from L'Illustration (General description of the proposed adhesion and rack railroad, to ascend 6300 ft. from Chamounix to the Mer de Glace). Sci Am Sup–May 16. 1000 w.

6042. Weight of Passenger Cars (A review of the American practice of building very heavy cars, and suggestion of return to lighter weights in the interest of increased speed possibilities). R R Car Jour–May. 1300 w.

6043. The Rules of Interchange from the Car Owner's Standpoint. Maurice (Communication representing the high value of private equipment to the railroad, and urging better and more liberal treatment of the owners, especially in the matter of repairs). R R Car Jour–May. 1600 w.

6044. Some Observations on Wheels. George S. Hodgins (Devoted chiefly to an argument as to the over-rated importance of depth of chill, and the underestimated value of good balancing and careful mounting). R R Car Jour–May. 1800 w.

6045. Passenger Carriage; Great Western Railway of England (Description, elevation and plan). R R Car Jour–May. 500 w.

6046. Paint Shop Staging (Description and drawings of a device to replace horses and planks in car-painting). R R Car Jour–May. 700 w.

*6047. Caledonian Passenger Express Engines (A full description with measurements and photo-engravings). Ry Wld–May. 450 w.

*6048. London Southern Tramways (Gives description and illustrations of double-deck and water cars, map of territory served, and data of fares, earnings, etc). Ry Wld–May. 900 w.

*6049. Side Pressure Ball Bearings (Describing and illustrating the application of ball bearings to street railway car service). Ry Wld–May. 1400 w.

*6050. Irish Railways and Their Purchase by the State (An argument for government ownership). Ry Wld–May. 3600 w.

*6051. Isle of Man Electric Tramways (A descriptive account of the system with statistical figures). Ry Wld–May. 2200 w.

*6052. Electric Traction Recommended for Glasgow (Report of a town council sub-committee, based upon a review of the situation in the principal continental cities). Ry Wld–May. 1400 w.

6053. The Government's Argument in the Joint Traffic Association Injunction Suit (An abstract of the government's position, as presented by Dist. Atty. Wallace Macfarlane, with editorial). R R Gaz–May 15. 2800 w.

6054. History of Electric Locking of Railroad Signals. V. Spicer (A paper read before the Railway Signaling Club, Chicago. The paper is devoted chiefly to the less familiar history of the application of the track circuit in connection with electrical locking of interlocking machine levers, and an argument for this practice). R R Gaz–May 15. 2200 w.

6055. The New Baltimore and Ohio Station in Baltimore (A description of the building with perspective and plan and plot of the depot grounds). R R Gaz–May 15. 1400 w.

6056. Railroad Matters in England. W. M. Acworth (London letter: the topics are accidents, punctuality, competition and London and Paris traffic). R R Gaz-May 15. 1400 w.

6057. The 109th Street Collision (The opinion of the Railroad Commissioners is criticised, and an argument made for the policy of written orders for each train all the time). R R Gaz-May 15. 800 w.

6058. The Reports of the Lake Shore and the Michigan Central (A statistical review of mileage, passenger and ton-mile, expenses and earnings). R R Gaz-May 15. 800 w.

*6102. The Consolidation of the London Tramways (Editorial argument in favor of a lease to a syndicate, with criticism of an adverse county council committee report. The conduit system of electric transmission is alluded to as practicable and successful). Engng-May 8. 2400 w.

*6106. Permanent Way (A series of communications devoted principally to discussion of English practice. Contains interesting comment upon the limit of advantageous rigidity). Eng, Lond-May 8. 3000 w.

*6107. The Fire Boxes of Locomotive Engines (A discussion of the difficulties of the internal fire-box and the defects of ordinary methods of staying, with favorable mention of the Belpaire fire box). Eng, Lond-May 8. 1700 w.

†6108. How Can Our Station Service Be Improved? F. E. Hoff (Paper read before the N. Y. R. R. Club. The recommendation is chiefly the institution of a station service department, with separate superintendent, inspectors, etc. This suggestion is amplified and explained, and followed by an extended discussion). N Y R R Club-April 16. 15500 w.

6113. Packing for Piston Rods and Valve Stems (A review of a paper by T. P. Purves, Jr., before the New England Railroad Club. The conclusions are favorable to metallic packing in preference to hemp, and some figures of maintenance cost are given). Ry Rev-May 16. 1200 w.

6114. The Liability of Employers (Summary of a case decided against the railway on the ground that under the circumstances the operator was a representative of the company and not a fellow servant of the injured employé. With editorial review). Ry Age-May 16. 2000 w.

6115. A New North and South Line. The K. C. P. & G. Route from the Grain Fields to the Gulf (Account and map of an important undertaking, predicted to be the inception of a new trunk line). Ry Age-May 16. 800 w.

6116. The "Black Diamond Express" (Description and photographs of the new Lehigh Valley train between New York and Buffalo). Ry Age-May 16. 700 w.

6117. The Evolution of a Fast Engine—How the Reading's High-Speed Passenger Engine with a Single Pair of Drivers Was Developed (The evolution is displayed by photographs of the successive stages, and measurements of the later types). Ry Age-May 16. 700 w.

*6120. Cost of Motor Maintenance (Part I is devoted to review of figures and records of Cleveland and Elyria, Springfield (Mass.), Nashville, Ogden, Montgomery (Ala.), Madison, Wis., Salt Lake City and some smaller roads). St Ry Rev-May 15. Serial. 1st part. 2500 w.

*6121. Testing Motors at Schenectady (Description and illustration of method in use at General Electric Company's Schenectady factory). St Ry Rev-May 15. 150 w.

*6122. A Problem in Street Railway Construction (The problem was connected with the change of cable road location (due to an extension of the stock yards) without interfering with regular traffic on the old line at any change point). St Ry Rev-May 15. 1600 w.

*6123. The Albany-Troy Electric Express Service (A brief account of the plans and operation, with illustrations of forms used and tariff rates). St Ry Rev-May 15. 1300 w.

*6124. Care of Commutators of Street Railway Motors. Walter C. Smith (Methods of cleaning and treatment to avoid sparking). St. Ry Rev-May 15. 700 w.

*6125. Brooklyn Heights Railroad to Carry Express (Introduction of express service on a large electric system). St Ry Rev-May 15. 1000 w.

*6126. First Three Phase Electric Railway in the World (Comment upon the electric tramway at Lugano, Switzerland). St Ry Rev-May 15. 450 w.

6147. Rapid Transit Street Railways. R. D. Fisher (A brief summary of all laws enacted by the legislatures of the respective States in 1895 pertaining to rapid transit on street railways, together with the book references). Elec Ry Gaz-May 10. 600 w.

6187. Electric Controller for Grade Crossing Alarm Signals (Illustrated description of a new device). Eng News-May 21. 500 w.

6189. A Geared Locomotive for Contractors' Use (Illustrated description with table of dimensions). Eng News-May 21. 800 w.

6190. The Joint Traffic Association's Defense (A synopsis of Mr. James C. Carter's brief for the defense, in the suit brought by the Government to dissolve the Association. With editorial review). R R Gaz-May 22. 4000 w.

6191. The Present Status of the Compound Locomotive in France (The first part reviews the recent rapid development of the compound locomotive in France and describes standard types, with measurements, and records of comparative tests. Illustrated with sectional and detail drawings). R R Gaz-May 22. Serial. 1st part. 2200 w.

6192. The Pecksport Connecting Line of the N. Y., O., & W. (A typical example of modern grade elimination, with calculation of resultant saving). R R Gaz-May 22. 400 w.

6193. A Compound Locomotive in Suburban Service (Interesting comparative statement of simple and compound locomotives, identical in everything except front end). R R Gaz-May 22. 500 w.

6194. Railroad Expenditures for Improvements and Equipment (A collation of recent and contemplated expenditures for the information of contractors and manufacturers). R R Gaz–May 22. 5000 w.

6195. April Accidents (A classified table, with descriptive comment). R R Gaz–May 22. 2200 w.

6196. The English Railway Clearing House (Extracts from a valuable descriptive paper, read by Dr. William Tausig, before the Commercial Club of St. Louis). R R Gaz–May 22. 1500 w.

6212. Railroad Ethics. H. D. Judson (Abstract of a paper read before the Western Railway Club. The writer considers present systems of discipline antiquated and defective, and pleads for broader and more advanced ideas. With editorial). Ry Rev–May 23. 4000 w.

6213. Philadelphia and Reading Tunnel and Subway in Philadelphia (Description, bird's-eye view and sectional drawings of an important work for elimination of grade crossing). Ry Rev–May 23. 1600 w.

6214. Railway Corporations (Railway rates. Limitations to the state's control of rates. Paper prepared for the convention of Railway Commissioners by A. B. Stickney). Ry Rev–May 23. 6000 w.

6215. Car Service Reforms (A forthcoming report to the International Association of Car Accountants, with an editorial argument for daily rental instead of mileage, for disregard of line marks, and a prediction of a great pool for joint ownership). Ry Age–May 23. 3000 w.

6216. The Effect of the Interstate Act. W. P. Clough (Read before the National Convention of Railroad Commissioners. The communication attributes rate cutting to the influence of important shippers, and depreciates the effect of the Interstate Commerce Act in maintaining rates). Ry Age–May 23. 3500 w.

6217. Illinois Central Improvements at Chicago (Description and full illustration with map, of an important piece of track depression). Ry Age–May 23. 3500 w.

6218. The Pooling of Engines (A discussion of the advantages and defects of the system in the Western Railway Club). Ry Age–May 23. 3000 w.

*6220. Power-Worked Tram Cars (The Serpollet system of steam propulsion described and illustrated with commendation for efficiency and economy). Engng–May 15. 2500 w.

*6239. Mallaig Railway and Harbor (Description and map of a West Highland Railway feeder of scenic and economic importance). Eng, Lond–May 15. 1500 w.

*6240. Economical High-Power Locomotives. James Dunlop (Description of application of Corliss valves to a Paris-Orleans locomotive, with general and detail drawings). Eng, Lond–May 15. 1400 w.

*6248. The Survival of the Fittest. Philip Dawson (Favoring electricity, and the trolley system, as motive power for street railways. What has been accomplished in the United States is cited in favor of the system with tables of traffic, expenses, &c). Elec Rev, Lond–May 15. Serial. 1st part. 2500 w.

*6253. Dublin Electric Tramways (Illustrated description of the tramway between Dublin and Dalkey, which is an important work in the history of electric railways of that country). Elec Eng, Lond–May 15. 5400 w.

6291.—$1.50. The Construction of a Light Mountain Railroad in the Republic of Colombia. E. J. Chibas (An excellent and very full description of typical construction in undeveloped country, where cheap first construction is essential, with map and half tones). Am Soc of Civ Engs–May. 8500 w.

6308. The Love Conduit System on Amsterdam Avenue (Illustrated description of construction and equipment. The line has not yet emerged from the experimental stage). Elec Ry Gaz–May 25. 1000 w.

*6309. The Altoona Shops of the Pennsylvania Railroad (The first article is devoted chiefly to a general description of the shop arrangement, buildings, and some special tools and methods. With editorial on car wheel matters). Am Eng & R R Jour–June. Serial. 1st part. 5800 w.

*6310. Should a Railroad Adopt Electric Motive Power to Meet the Competition of Electric Suburban Lines? (Extracts from report of Mass. R. R. Commission; the conclusions being that the province of each is distinct, and no advantage will result from an attempt on the part of either to invade the other's field). Am Eng & R R Jour–June. 2000 w.

*6311. The Use of Graphical Methods in Keeping the Accounts of Railway Mechanical Departments (An advocacy of the system, with illustration taken from a large western road). Am Eng & R R Jour–June. 900 w.

*6312. Pumps vs. Compressors for Shop Use (An exhibition of the great wastefulness in operation of pumps for this service). Am Eng & R R Jour–June. 1200 w.

*6313. A Substantial Indicator Rigging for Locomotives (Description and illustration of the Penna. R. R. rig, important on account of increasing use of indicator on locomotives). Am Eng & R R Jour–June. 800 w.

6319. The Outlook for Rapid Transit in New York City (Editorial review of the peculiar difficulties and an argument for the tunnel scheme). Eng News–May 28. 2200 w.

6320. The Hardie Compressed Air Motor for Street Cars (A descriptive account with some results of tests). R R Gaz–May 29. 1200 w.

6321. National Convention of Railroad Commissioners (A condensed report of the Washington meeting. The papers and discussions are devoted to various phases of the relation of railroads to the public and to the government). R R Gaz–May 29. 4800 w.

6322. Plan for Removing Grade Crossings in Newark, N. J. (A descriptive account, with plan and profile). R R Gaz–May 29. 900 w.

6323. Rapid Transit in New York (An editorial review in the light of the court's decision against the plan of the commission. The solution favored is a development of the elevated system). R R Gaz-May 29 3500 w.

*6328. Vibration Meters (Description of a seismograph especially adapted to railroad locomotives and vehicles. It is claimed that greatly increased economy and safety will result from study of its cards and correction of the defects thereby discovered). Engng-May 22. 1600 w.

6331. Locomotive Rating and Fuel. Tracy Lyon (Abstract of a paper read before the Western R'way Club. An exposition of the latest practice with an account of the very practical method employed on the Chicago Great Western R'way). Ry Rev-May 30. 2700 w.

6332. New Eight-Wheel Passenger Locomotive. C. R. I. & P. Railway (The engine is designed to give equal service with ten-wheeled engines, with greater economy. Descriptive account with diagrams giving principal dimensions, and drawings of some details). Ry Rev-May 30. 1000 w.

6333. Decision of the United States Court of Appeals in the Gould-Trojan Coupler Case (Abstract of an opinion reversing the order of the circuit court, which was for an injunction *pendente lite*). Ry Rev-May 30. 3000 w.

6337. Rules Governing Engineers—The System in Force on the Soo Line by Which Engineers Engage Their Own Firemen (The rules are given fully in a copy of the letter addressed by the mechanical superintendent to each engineer in the company's service). Ry Age-May 30. 1800 w.

*6338. New Erie Passenger Engine (A description with photograph and sectional drawings. The engine has some novel features in frames and size of steam parts). Loc Engng-June. 500 w.

*6339 An Automatically Closing Steam Fountain that Will Close. John A. Hill (Drawings and description of a device to lessen danger to enginemen from escaping steam. The invention is not patented, but given to the public). Loc Engng-June. 1200 w.

*6340. Southern Railway Air-Brake Instruction Car No. 108 (Brief account with excellent illustrations of an interesting development of modern railroad educational work). Loc Engng -June. 800 w.

*6341. New York, New Haven & Hartford 60,000-pound Coal Cars (The article is illustrated by dimension drawings, and notes some improvements in construction designed to meet the severe strain endured by large cars). Loc Engng-June. 800 w.

*6342. How Cars Are Cleaned by the Wagner Palace Car Co. (The account is designed to show how fully important sanitary requirements are complied with). Loc Engng-June. 700 w.

*6343. Extended Front Ends (A symposium of correspondence, tending to show that the device was a gradual development for which individual credit would be hard to apportion. With editorial). Loc Engng-June. 2200 w.

*6374. The Rouen Electric Tramways. Ill. (Discussing the leading features and characteristics of the work from a critical or comparative standpoint). Elec Rev, Lond-May 22. 3000 w.

†6423. The Future of Electricity in Railroad Work. Dr. Louis Duncan (A lecture delivered before the Franklin Institute. A very full and able discussion of the case in all its relations. Electricity is regarded as specially adapted at present to suburban travel, and short feeder lines, but destined to supplant steam, first for through passenger travel ; lastly, and perhaps doubtfully, for through freight). Jour Fr Inst-June. 5800 w.

6434. The Bergen County Traction Company's System (Illustrated description of the new road from Pleasant Valley to Englewood, N. J). Elec Eng-June 3. 1800 w.

6439. The Form of the Exhaust Jet in Locomotives. J F. Deems (Abstract of a paper read before the Western Railway Club. A recital of recent experiences as a member of a committee on proper height, form and arrangement of exhaust jets). Eng News-June 4. 2100 w.

6444. The Joint Traffic Association Sustained (Substance of Judge Wheeler's decision, denying the Government's motion for an injunction. With editorial). R R Gaz-June 5. 2500 w.

6445. Railroad Legislation in New York State (Summary of bills affecting railroad interests passed by the N. Y. legislature in 1896). R R Gaz-June 5. 1000 w.

6447. Performance of the Purdue Locomotive "Schenectady." W. F. M Goss (Read at meeting of W. Ry. Club. A full reprint. The tests bring out some very interesting relations of speed to power and are summarized in an argument for large drivers). R R Gaz-June 5. 2700 w.

*6452. Railway Construction in Asia Minor (A review of the present status, with explanatory comment on the rise of continental and decline of British interest and influence). Trans-May 29. 1300 w.

*6453. The Railways of Cape Colony and Natal (A brief descriptive and financial review for 1895). Trans-May 29. 1400 w.

*6462. The South-Eastern Railway and Its London Traffic (A vivid description of a traffic which has outgrown its facilities. Illustrated by diagram showing "stringing" of the card between 8 a. m. and noon). Engng-May 29. 1100 w.

*6472. A Method of Estimating the Probable Volume of Traffic on New Railways (W. H. Schuermann (A discussion and illustration of Richard and Mackensen's method as applied to American railways, accompanied by tables, formulæ and graphic diagrams). Eng Assn of the South-April. 5000 w.

6480. The Organization of the Chief Engineer's Department of an Extensive Railway. Walter Katte (Deals with the functions of the engineer and the apportionment of members and duties in the various departments of construction and maintenance work). Ry Rev-June 6 1900 w.

SCIENTIFIC MISCELLANY

Bacteria in Milk.

PROFESSOR H. W. CONN, of Wesleyan University,—a distinguished biologist,—points out the sources of contamination of milk in the *Spatula* (reprinted in *Scientific American*, May 2). Pure milk secreted by a healthy cow contains no bacteria, and, as long as bacteria are perfectly excluded, it remains sweet, suffering none of the ordinary changes, except the natural separation of the cream from the heavier liquid portion. The problem of excluding injurious bacteria, or of destroying them after they have gained access to milk, is the fundamental one in the great milk and dairy industries of the world.

If only healthy cows are milked, how and whence do the bacteria get into milk. Professor Conn says that by the time the milking of a cow is completed the milk will contain a large population of bacteria, but only a very few of these are from the surrounding air. " Part of them are already in the milk pail. The dairyman never washes his milk pail free from bacteria. Even with the most thorough washing which the pails receive on the ordinary farm, the bacteria are not killed, but remain alive, adhering to the cracks in the tin, or in the crevices in the wood. Part of them come from the milker, for he commonly goes to the milking without any special toilet, with his hands not clean, and clothed in the ordinary farm clothes, which have become filled with bacteria from numerous sources. But by far the greatest number come from the cow herself. These are not, however, from the interior of the cow, but from her exterior. First, her flanks are always covered with dirt. Frequently they are covered with layers of dried manure, and always the hair of the legs, sides, flanks, and tail are covered with a large amount of dust and dirt. All of the dirt and manure is crowded with innumerable hosts of bacteria. Again, the milk ducts of the cow's teats form a prolific breeding-place for the bacteria. After each milking, some milk is left in the milk ducts, and in this the bacteria which may get to teat from the air or the dirt or hairs of the cow find abundant food. Here they multiply, and by the time of the next milking they are present in countless millions, ready to be washed out with the first milk that is drawn."

It becomes evident that cleanliness is a virtue of high rank in all that pertains to the treatment of milk as a commercial product. The milk as first obtained is not only one of the most nutritive substances for the growth of bacteria, but its temperature is almost that of the blood of the animal, and as nearly as possible such as promote the rapid growth and multiplication of these destructive agents. Hence is apparent the value of rapid cooling as soon as the milk is obtained and filtered. No practical method of filtering will remove the bacteria, but " immediate and rapid cooling so greatly checks the growth of bacteria as to greatly reduce the number present in the course of twenty-four hours. This is the explanation of the fact that the milk dealer not infrequently has complaints from his patrons that his morning's milk sours, while no such complaints are received of the milk of the night before. The latter was cooled during the night, while the former was taken to delivery at once from the cow or with insufficient cooling. For this reason it actually sours quicker than the milk of the night before, which needs to warm up before the bacteria can grow in it rapidly."

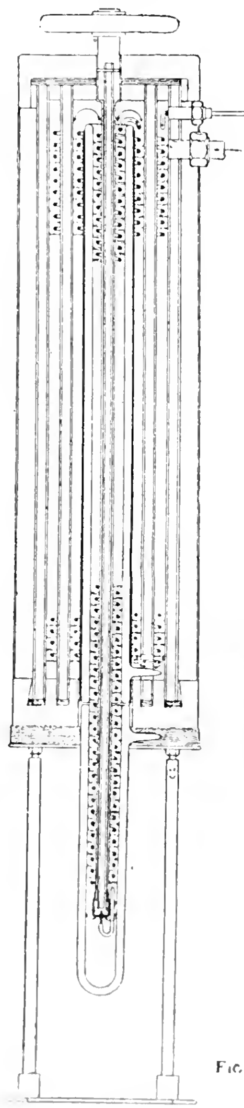
There are more than one hundred species of bacteria which infest milk. " Some of them sour it by changing the milk sugar to lactic acid. This, as well known, is the most common effect arising in milk upon standing, but others produce other results. Some of them make the milk bitter ; some curdle it, but render it alkaline or sweet to taste ; others give it an unpleasant, tainted taste ; others, again, render it slimy or ropy; some turn it blue or yellow or red."

The presence of some kinds of these bacteria is beneficial. The "ripening" of cream is one of the benefits. "This ripening is nothing more than a fermentation due to the growth of the bacteria which are in the cream. During this twenty-four to forty-eight hours the bacteria which were in the cream multiply rapidly. This growth produces a fermentation, just as the growth of yeast in the brewery malt produces its fermentation.

"The object of this ripening is at least threefold. First, it makes the cream churn more readily, and, second, it gives a larger amount of butter from a given lot of cream. The third object is to give flavor to the butter." These changes result from chemical changes effected by the presence of bacteria, the first products being agreeable to taste and smell; but, if the action be too long continued, unpleasant flavors are produced, and the latter may also be produced in milk almost fresh from the cow by the presence of deleterious bacteria. The ripening of cheese also results from bacteria present in it, and the different flavors of the different varieties of cheese result from the action of different kinds of bacteria under conditions of temperature, light, and exposure to air favoring the growth of one species more than another, in a manner precisely analogous to the growth of different kinds of ferments in the wort of beer in brewing, by which different flavors in malt liquors are produced during the fermentation.

The New Process for the Liquefaction of Gases.

To what purposes liquefied air may be applied in the arts is yet undetermined. One purpose, however, we venture to suggest, may be its use in pneumatic guns for projecting dynamite shells. A pound of liquefied air occupies only a few cubic inches of space, and in this state, by absorption of heat from its surroundings, it can store up a very large expansive energy. This energy is represented in terms of work by its increase in volume during the resumption of its gaseous condition against the external pressure of the atmosphere plus the energy inherent in one pound of gaseous air under ordinary conditions, expressed also in terms of work. At normal pressure and temperature the volume of one pound of gasified air is about thirteen



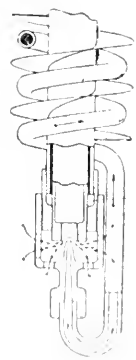


FIG. 2.—Detail of valve

FIG. 1.—Sectional elevation

cubic feet. A small weight of liquefied air placed in an evaporator of minute dimensions could soon be made to generate a large volume of gaseous air under a pressure of, say, one thousand pounds per square inch, which is not far from the pressure used in pneumatic guns; and the only limitation to pressure is mechanical and practical,—to wit, tight fitting of joints, etc., to prevent leakage.

Pertinent to this question of utility is a description of Dr. William Hampson's new apparatus for liquefying gases, condensed from *Nature* (April 2).

The apparatus consists of three coils of narrow copper tubing, arranged concentrically in a metal case, and connected successively together, as in Fig. 1,—a vertical section of the apparatus. The gas, say oxygen, enters the coil, which is surrounded by a cylindrical-glass vacuum-jacketed vessel, as devised by Prof. Dewar. The two outer coils are separated from each other by vertical divisions of the case, and the spiral of the central coil is followed by a flat spiral of sheet copper. When the gas reaches the extremity of the central coil, it escapes through a fine orifice of peculiar construction, formed by bringing two knife-edges closely together (shown in Fig. 2). The size of the orifice can be regulated by means of an ebonite rod, which passes up the axis of the apparatus, and terminates in a handle at the top. After its escape, the whole of the gas cooled by expansion passes through the spaces surrounding the pipe through which the compressed gas is passing to the point of expansion, and so makes this gas, still under pressure, cooler than it was itself while under compression. The compressed gas consequently becomes at the point of expansion cooler than that which preceded it, and in its turn follows backwards the course of the still compressed gas, and so makes the latter cooler than before expansion, and therefore also cooler than ever after expansion. This intensification of cooling (always assuming sufficient protection against access of heat from the outside) is limited only by the liquefaction of the gas,—the temperature of liquefaction being, in the case of oxygen, — 180°C.

The apparatus is only twenty-eight inches high, and seven inches in diameter, and yields seven cubic centimeters of liquefied oxygen in four minutes. No other artificial cooling agent, inside or outside, is needed. It is expected that by this apparatus, which may, of course, be made of much larger capacity,—it being merely a working model,—the liquefaction and, perhaps, the subsequent solidification of hydrogen will be achieved, and thus enable an exact study in the liquid and solid state of this important elementary substance to be made.

The attainment of the absolute zero is not far away from the low temperatures now obtained; and it is not improbable that the study of matter at the absolute zero of temperature may be possible before the end of the present century.

Admission Requirements of Engineering Schools.

As a side-light on the current discussion of the value and methods of modern engineering and technical schools, a letter to *American Machinist* (June 4) is extremely interesting. Mr. William O. Webber having asked, in the columns of the paper named, where "the ideal school, turning out good foremen, superintendents, chief engineers, and professional men can be found." Mr. Mark Talcott, the correspondent referred to, thinks the question can be at least partially answered by a table of occupations in which post-graduates of Worcester Polytechnic Institute are now engaged; and he presents the table accompanying this review.

He explains that the table is a "*résume* of the entire graduate body for the years 1871 to 1895, inclusive, embracing a total of 650 men in fourteen classified occupations, the figures in the body of the table giving the percentage (based on the total membership of each class) of its members in each occupation. The number of men on which the percentages in each case are based is found at the foot of the column bearing the year of the class graduation.

"Of the 650 men recorded, but 4 per cent., or 26 men, are not engaged actively in lines of work for which the Institute course specially prepared them. Of the remaining 164 men in unclassified occupations, marked 'Others,' it may be said that the catalogue of the Institute does not give with sufficient clearness the occupations of these, though they may in general be classified with the others; and this classification is in no way an indication that they are not in active service in some of the lines that are mentioned. A reference to the table will show at a glance that the largest proportion of the men get into business for themselves. This is especially true of the older classes. The next grade may be named as the 'managers in business,' and in this grade, as well, the older classes are largely represented. 'Superintendents,' 'mechanical engineers,' and 'assistant engineers' are also well filled out with older classmen. The positions of 'draftsmen,' 'professors and instructors,' 'chemists,' 'electricians,' and others are more fully occupied by the more recent graduates; and also, the proportion of the unclassified is far greater in the recently-graduated classes. The logic of the table would therefore seem to be that the more responsible positions are gained after years of service, to which the Institute training is merely the foundation, and in no way a part of the superstructure. At this juncture it is pertinent to point out, therefore, that no institution, however thorough or severe its course of instruction and training, can be supposed to turn out anything, —foremen, superintendents, or anything else. It simply turns loose a lot of raw material, from which, later on, these various grades of engineers may develop."

Occupation.	Year of Graduation.																									Total for Each Grade.
	1871	1872.	1873.	1874.	1875.	1876	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	
Partner in business.	37	50	16	23	62	35	23	29	35	7	29	32	28	37	16	31	23	21	9	6	9	..	..	2	2	119
Manager in business	..	..	16	7	6	10	5	17	10	14	6	11	.	13	15	7	6	..	..	6	6	3	6	..	..	37
Superintendent	6	..	8	8	6	..	.	5	..	7	23	11	6	13	16	10	..	3	6	..	..	3	2	3	2	32
Mechanical Engineers	6	..	12	..		6	5	..	5	..	..	..	11	.	4	3	7	..	..	12	3	3	6	2	..	22
Assistant C. E. and M. E	12	6	6	8	..	23	24	6	10	21	12	3	.	8	4	7	10	9	..	12	6	9	2	9	..	48
Assistant Superintendent	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	6	..	..	3	2	3	2	6
Draftsmen	..	..	6	..	..	6	5	12	5	..	6	11	17	8	..	3	..	12	16	12	9	21	12	13	28	63
Professors and Instructors	6	12	6	15	..	12	5	.	10	7	..	6	11	4	8	17	23	18	12	12	10	3	7	13	3	61
Chief Engineer	..	..	..	..	..	..	..	..	..	..	..	7	..	4	..	..	.	3	..	..	..	..	..	..	..	4
Master Mechanic	6	6	..		..	..	..	..	..	..	..	.	..	4		..	..	3	..	..	..	..	..	..	..	4
Chemists		..	..	..	..	..	..	6	..		6	..	..	..	..	..	3	9	.	9	6	6	8	..	7	20
Electricians	..	..	..	..	..	..	..	..	..	7	..	4	..	..	..	..	..	..	18	6	3	3	5	3	..	17
Examiner. U. S. Patent Office	..	..	..	..	..	-	..	..	..	..	..	..	..	..	..	..	10	..	6	..	3	12	6	..	..	13
Assistant Manager	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	.	..	..	3	..	..	2	..	..	2
Others	21	26	30	39	26	8	28	25	25	37	18	18	27	9	37	22	18	22	27	21	42	32	42	52	56	190
Total in each class.	16	16	16	13	16	17	21	17	20	14	17	28	18	24	25	29	30	33	33	33	31	32	49	47	47	650

NOTE—The figures in the body of the table give the *percentage* based on the number in each class of its members in each occupation.

Mr. Talcott will not be displeased, we think, at an amendment which we propose to his last proposition. In many senses the material turned out by the technical schools is raw; it needs a good many processes before it can become the widely-demanded, finished, merchantable article; but, if it has not been materially advanced from original crudity, a reason for the existence of the schools is not apparent. It is necessary to show (and it can doubtless be shown) that the positions that these graduates now hold were attained in a sufficiently shorter time from their matriculation, and that their efficiency in their several professions or occupations has been sufficiently enhanced, to repay the expense of time and money entailed by the courses of study pursued. We repeat that we have no doubt that this could be proved, and therefore we would not use the unmodified term "*raw material*" as applied to the graduates of engineering schools. We prefer the term "*prepared*," or "*improved*," raw material.

Discharge of Rivers as Influenced by Forest Removal.

IT is a commonly-received opinion that the flow of streams and also climatic conditions are permanently influenced by the removal of forests. Mr. Dwight Porter, of the Massachusetts Institute of Technology, has been testing the accuracy of this belief, so far as observations upon flow in the Connecticut river throw light upon it; and he gave results in a paper read last year before the American Forestry Association.

This river was selected among the very few streams upon which reliable and long-continued observations have been made, and upon whose upper drainage area the clearing of forests has been going on for many years. From this paper, in *Science* (April 17), it appears that no permanent change of flow can be predicated, as indicated in the records from 1841 to 1895.

"The theory as to the effect of forests is that, by shading the ground, they tend to prolong the melting of snow in the spring, and thus to prevent excessive freshets, as well as to maintain the naturally-decreasing flow of late spring and early summer. Further, by reducing the evaporation from the ground, by obstructing the free flow of surface water after rains, as well as by conserving the snows, they tend to maintain a large volume of ground water, which, issuing in visible springs or in invisible seepage, must of course be the reliance of all streams in dry weather. The effect of extensive forest-cutting might, therefore, be expected to be an increase in the number, suddenness, and height of oscillations, and, on the other hand, a more speedy falling away in summer, and a lower range of dry-weather flow."

Professor Porter admits, however, that records of flow for longer periods than are available are needed to positively determine the effect of forest-cutting upon streams. He also notes that such effects upon the Connecticut river should be most evident for the past twenty-five years in the upper river; but the only records available are those made at Hartford and Holyoke.

"At Hartford the tributary area is about 10,200 square miles, and for a period of over fifty years records are available of the maximum freshet height of each year. Further, observations to determine the daily rate of discharge were begun in 1871 by General Theodore G. Ellis, and were continued without interruption until 1886, although for 1882 and 1883 the figures are not at hand. There was thus obtained a record having few parallels in this country, and it is deeply to be regretted that the United States engineers should have permitted it to be discontinued, as was done in 1886. At Holyoke, where the drainage area is about 8,000 square miles, the Holyoke Water Power Company has maintained since 1880 a daily record of the discharge of the river past that point, which record is still continued, and is on the whole the most valuable that now exists regarding the discharge of this stream."

Averaging these records, both for freshet height and for low-water flow, no indications of permanent change are found in either. Tables of heights and of flow, with a diagrammatic representation of the same, are presented, and confirm the opinion, "The highest freshet was in 1854, the lowest in 1858, and only twice has the height of 27.7 feet, attained in 1801, been exceeded. Apparently there was a gradual increase in the *average* height down to 1880, while at the same time there was a marked and steady decrease from 1854 to 1880 in the heights of the more extreme freshets."

Source of the X Rays.

In notes of observations on the Röntgen rays, Professors Henry A. Rowland and L. J. Briggs, in *The American Journal of Science* for March, announce their opinion that the source of the rays seems to be more connected with the anode than the cathode.

In making the above announcement, the writers state that they have been unable to obtain any trace of reflection from a steel mirror at a large angle of incidence,—an effect noted by Röntgen,—but, in their experiments, the mirror was on the side of the photographic plate next to the source of rays, while in Röntgen's method the mirror was placed behind the plate.

In a subsequent communication to the *Electrical World*, the authors express a modification of the view above stated. They still think the anode or its equivalent is the main source of the X-rays, yet they now say they have evidence that in some of the tubes it is necessary that the cathode rays shall fall on the anode in order that the Röntgen rays may be formed.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Scientific and Engineering Journals—See Introductory.

†5780. Natural Science in a Literary Education. Albert H. Tolman (In the present state of the educational question, the opinions and arguments contained in this attempt to show what ought to be the attitude toward science, of those students who wish a literary education, will be read with interest). Pop Sci M–May. 2300 w.

†5781. Recent Work on the X-Rays (A general résumé of progress compiled from many sources, largely from the technical periodicals of Europe and America). Pop Sci M–May. 3000 w.

5787.—75 cts. Calorimetry. Methods of Correction for Cooling, Silas W. Holman (A general method of treating the cooling correction which is applicable to nearly all non-continuous calorimetric processes, such as the measurement of specific heats by the "method of mixture" of heat of combustion by the Berthelot or Mahler bomb, etc. It is reliable in ordinary practice within the limits of error imposed by the thermometry and by irregularity of conditions as to surroundings. The paper claims the attention of those who desire a concise working statement of a method of cooling correction which has stood the test of practice). Tech Quar–Dec. 2500 w.

5788.—75 cts. Thermo-Electric Interpolation Formulæ. Silas W. Holman (In this paper are collected the several well-known types of formulæ for expressing the thermal electro-motive force of a couple as a function of the temperaature of its junctions. Two new formulæ are also proposed. All then are tested against the most reliable, experimental data upon the subject, and their relative merits discussed). Tech Quar–Dec. 5500 w.

*5803. The Production of Caustic Soda and Bleach by Electrolysis (Editorial discussion of the Holland process, which is pronounced a marked improvement over all hitherto existing processes, and destined to effect a notable reduction in the cost of caustic soda). Engng–April 24. 1800 w.

†5821. A Simple Method for Determining the Neutrality of the Ammonium Citrate Solution Used in the Analysis of Fertilizers. N. W. Lord (A method which has been used in the writer's laboratory and has proved rapid and exact. The details of the method are given). Jour Am Chem Soc–May. 450 w.

*5844. Steel Storage Tanks for Grain (Illustrates and describes structures of this kind in use at the Manhattan mill, Toledo, Ohio). Am Miller–May 1. 1100 w.

*5845. Relation of Color to Value in Flour. (A recent lecture before a bread-making class at Salisbury, England, describing a new method whereby color of flour can be made to indicate its quality, and stating the significance of different tints and shades, determined by scientific investigation). Am Miller–May 1. 1700 w.

*5849. The Röntgen Rays. J. J. Thomson (Some remarks on the investigations of M. Henri Becquerel interesting on account of the differences as well as the analogies disclosed between uranium radiation and the Röntgen rays, followed by review of late experiments and progress). Nature–April 23. 2200 w.

*5850. On a New Form of Radiation. Wilhelm Konrad Röntgen (Second communication of the writer's investigations, giving some new results). Elect'n–April 24. 2000 w.

*5851. Discharge Phenomena in Rarefied Metallic Vapors. E. Wiedemann and G. C. Schmidt (An account of experiments with metallic vapors showing (1) that in a heated conducting glass bulb, rarefied metallic vapors may be made to glow by oscillating discharges. (2) In metallic vapors the typical discharge phenomena occur, even in monatomic ones. Color and spectrum of the first and third glow-light strata and of the positive light are essentially different). Elect'n–April 24. 1200 w.

*5852. On a Crookes Apparatus. H. Pfloum, in *Wied. Ann* (Description of the behavior of a 7 B bulb). Elect'n–April 24. 800 w.

*5853. On the Effect of the Röntgen X-Rays on the Contact Electricity of Metals. James R. Erskine Murray (The experiments described were made in the Cavendish Laboratory of the University of Cambridge, at Prof. J. J. Thomson's suggestion, in order to find whether the contact potential of a pair of plates of different metals is in any way affected by the passage of the Röntgen X-Rays between the plates). Elect'n–April 24. 1200 w.

*5854. On the Behavior of Argon and Helcum When Submitted to the Electric Discharge. i. N. Collie and William Ramsay (Experiments Jarried out more with a view of obtaining practical help in recognizing the purity of argon and helium than of carrying out a research on the relative conductivities of gases). Elect'n–April 24. 1800 w.

*5857. Sixty-Eight Octaves. T. H. Muras (Table showing, on a uniform scale, the relations of the different kinds of vibrations now known). Elec Rev, Lond–April 24. 250 w.

5863. Theory of Burning Clay Ware. Max A. Th. Boehncke (A review of some things necessary for the successful burner of clay to know). Brick–May. 3000 w.

5867. On the Reflection of Röntgen Rays.

O. N. Rood (Abstract of paper read before the National Academy of Science. Experiments claiming to demonstrate the regular or specular reflection of the Röntgen rays). Elec Wld-May 9. 600 w.

†5887. A Classification and Catalogue System for an Engineering Library. F. R. Hutton (Read before the A. S. M. E. General discussion of library cataloguing, and an attempt to evolve a good system for engineering libraries). Trans Am Inst of Mech Engs-Vol. XVII. 3800 w.

5901. Rice Culture in Southwestern Louisiana. H. H. Childers (Illustrated popular description). Sci Am-May 9. 1200 w.

5933. The Cyclotomic Transit (Illustrated description of a new transit with only one central spindle, turning within the leveling head, and in which the azimuth circle plate is made a part of the rigid substructure. Correlated with this is a floating ring upon which the figures representing degrees are marked, so that instead of turning the whole plate, only the floating ring is in use, turned around the central vertical axis) Eng & Min Jour-May 9. 900 w.

†5935. Artificial Legs and Arms of Rubber. Gustav Heinsohn (Historical account of the use of rubber in this effort to contribute to the comfort of man, with illustrated d scription of some late work). Ind Rub Wld-May 10. 2000 w.

†5936. Shoe Lasts and Boot-Trees for Rubber Footwear (An account of the different substances used for this purpose, with reference to the expense to the trade from the necessity of the many styles, and the effect of heat, &c., on the various materials from which they are made). Ind Rub Wld-May 10. 2500 w.

5937. The Rubber Situation in Madagascar (Brief description of the growth of rubber yielding plants, with account of the practice of the native rubber-gatherers, and the prediction that the industry is destined to become more important). Ind Rub Wld-May 10. 1300 w.

*5945. Quackery in Engineering Education. Edward H. Williams, Jr., D. C. Jackson, H. K. Landis, and George L. Hoxie (A symposium suggested by Prof. Kidwell's article on the same subject). Eng Mag-June. 4200 w.

5950. Note on a Breathing Gas Well. Harold W. Fairbanks (Brief description and remarks upon a well situated on the Eagle Ranch, in San Luis Obispo Co., California, which gives an intermittent flow of natural gas). Science-May 8. 900 w.

5951. Source of X-Rays. A. A. Michelson and S. W. Stratton (Illustrated description of experiments which appear to prove that in a vacuum tube, of a form specified, the X-rays radiate in all directions from the surface first encountered by the cathode rays). Science-May 8. 500 w.

5952. The Color of Water, as Affected by Convectional Currents (Review of an interesting study by Prof. W. Spring, of Liège, of the causes that impart color to water in masses). Science-May 8. 600 w.

5953. The Plasticity of Ice Crystals (Brief review of an experimental study by Dr. O. Mudge, which shows that the bending of ice, acts in the direction of its optic axis, and that plastic translation without bending is only possible in a plane perpendicular to the optic axis). Science-May 8. 300 w.

5954. On Rood's Demonstration of the Regular or Specular Reflection of the Röntgen Rays by a Platinum Mirror. Alfred M. Meyer (A criticism upon Dr. M. I. Pupin's criticism of Prof. Rood's account of experiments, wherein the latter says the results point to the conclusion that in the act of reflection from a metallic surface, the Röntgen rays behaved like ordinary light. Dr. Pupin having denied the fact of regular or specular reflection in Prof. Rood's experiments, Prof. Meyer says, that after a careful examination of Prof. Rood's negatives, he thinks regular and specular reflection of the x-rays are demonstrated facts). Science-May 8. 600 w.

5955. Pseudo-Science in Meteorology. B. E. Fernow (A warning against erroneous observations, and fallacious conclusions, relating to effects of forest removal upon water-flow, and upon meteorological phenomena, especially on water-flow in the western mountains). Science-May 8. 1600 w.

†5993. The Proposed Gigantic Model of the Earth. Alfred R. Wallace (A criticism of the recently elaborated scheme of M. Elisée Reclus, for the construction of a gigantic model of the earth—418-ft. in diameter—and a description of a substitute, considered by the author as possessing far greater advantages, and which would cost much less to construct). Contemporary Rev-May. 4500 w.

*6018. Recent Researches on the Röntgen Rays M. Guillaume in *La Nature* (The writer states that investigations are being extended in three distinct directions. In the first place, attempts are being made to discover the properties of the new rays; second, apparatus for producing and utilizing them are being perfected; lastly, investigations as to the source of the different rays of the vacuum tube. Experiments are discussed and illustrated). Elec Rev, Lond-May 1. 2200 w.

*6024. Recent Work with Röntgen Rays (Notes on papers and communications received during the last few davs previous to date, and supplementary to J. J. Thomson's article in last number of same paper). Nature-April 30. 5500 w.

*6025. Color Photography. Prof. Lippmann (Read before the Royal Society. Description and demonstration of researches in color photography). Nature-April 30. 2800 w.

†6027. Solids and Vapors. Wilder D. Bancroft (An interesting study of the phenomena of deliquescence and efflorescence, showing that these phenomena are influenced by variable conditions of temperature and vapor tension, and stating the conditions under which crystals of anhydrous and hydrated salts will be permanent or otherwise. All the conclusions are concisely stated at the end of this able paper). Phys Rev-May-June. 6000 w.

†6028. On the Heat Effect of Mixing Liquids. C. E. Linebarger (An experimental research.

Details of experiments are presented, and the results are given in tabulated form). Phys Rev–May-June. 5000 w.

†6029. The Influence of Heat, of the Electric Current, and of Magnetization upon Young's Modulus. Mary Chilton Noyes (Describes methods, apparatus and experiments directed to distinguish between the effects upon Young's modulus due to heat, to the longitudinal magnetization and the electric current through a wire, and instituted to investigate certain unexplained and irregular results in a previous set of experiments in which an electric current was used as a source of heat, in determining the effect of temperature upon this modulus for a piano wire. The results are illustrated by diagrams and afterward presented in tabulated form). Phys Rev–May-June. 4500 w.

†6030. A Method for the Use of Standard Candles in Photometry. Clayton H. Sharp (This study of photometry is based upon the proposition that in a photometric test the rate of consumption at the instant at which a photometer setting is made ought to be known ; but, as this is impracticable, a series of experiments for the investigation of the relation between flame height and intensity, and to determine whether such a relation would not enable more consistent results to be obtained than by the method of correcting for rate of consumption, is described, illustrated by diagrams and the results tabulated). Phys Rev–May-June. 2500 w.

†6031. The Graphical Representation of Magnetic Theories. Harold N. Allen (The object of the paper is to insist on the distinction between Faraday's theory of magnetism, and the older theory—which assumes the existence of magnetic fluids covering the ends of the magnet—still often made use of, because mathematically simpler, and at the same time to consider some points in the induction theory itself. Different aspects of the theory are illustrated by diagrams, and the discussion is on mathematical as well as physical lines). Phys Rev–May-June. 2000 w.

6037. On Apparatus for Cathography. Nikola Tesla (The writer has found that the most suitable apparatus, and one which secures the quickest action, is a disruptive coil. Directions are given for use). Min & Sci Pr–May 9. 1400 w.

6041. The Source of Röntgen Rays. Ill. Alexander Macfarlane (Further experiments on the source of Röntgen rays, from which cathode rays appear to be due to radiant matter, while Röntgen rays appear to be light waves too short to lie within the range of vision). Elec Wld–May 16. 700 w.

6059. Behavior of Sugar toward Röntgen Rays. Ferdinand G. Wiechmann (Tests made by the writer, showing that amorphous sugar is more transparent to the X-rays than the crystalline). Science–May 15. 700 w.

6060. The X-Rays in Medicine and Surgery. Charles L. Norton (The application of X-rays to the diagnosis of disease. Tests that make it seem that a very wide field is open to medical as well as surgical investigations). Science–May 15. 550 w.

6063. Manufacture of Calcium Carbide. Orrin E. Dunlap (Illustrated description of the plant at Niagara Falls). W Elec–May 16. 2000 w.

†6082. Corn Oil. Harry W. Allen (An investigation of the physical and chemical properties of corn-oil now used as an adulterant, but which is produced in large quantities, and if practical uses could be found might become a more important article of commerce). Engineers' Year Book–Univ of Minn. 1200 w.

*6090. High Explosives and Smokeless Powders. Hudson Maxim (Deals with the effects of high explosives as destructive agents of warfare, with diagrams illustrating these effects, the qualities required in a good smokeless powder of high explosive character, and describes the Maxim powder, with tables of results attained in government experiments with guns of various calibers, at Sandy Hook. Discussion). Jour Soc of Arts–May 8. 5700 w.

6118. How Belleek Ware Is Made (An interesting description of this celebrated porcelain). Clay Rec–May 14. 1000 w.

6119. How Terra Cotta Is Made. From the *New York Times* (Interesting description of process, with remarks on the durability, extensive use, raw material, etc). Clay Rec–May 14. 2700 w.

6175. Photography in Vacuo. Joseph Cottier (Notes intended to throw light on this subject. The bulk of evidence is to the effect that a sensitive plate retains its impressibility after removal of the air). Elec Wld–May 23. 1600 w.

6177. Roentgen Rays. Philip Mills Jones (Considers the source and nature of the rays and their possible usefulness). Min & Sci Pr–May 16. 2500 w.

6179. Artificial Flight Successfully Achieved by Prof. Langley's Aerodrome (Letter from Alexander Graham Bell, with explanations by Prof. Langley, describing briefly a trial of this machine and its successful operation). Sci Am–May 23. 800 w.

6180. Modified Milk (An illustrated description of scientific preparation of milk for food). Sci Am–May 23. 1600 w.

6197. The Embankments of the River Po. Frank D. Adams (Interesting facts relating to this embankment and the rapid advance of the sea upon the shores of Lombardy and adjacent shores of the Adriatic). Science–May 22. 1500 w.

*6221. Experimental Error (Editorial review of A. B. W. Kennedy's "James Forrest lecture" on Physical Experiment in Relation to Engineering). Engng–May 15. 1600 w.

*6222. Physical Experiment in Relation to Engineering. Alexander Blackie William Kennedy (The "James Forrest" lecture delivered at the Inst. of Civ. Engs. Physical experiment is regarded not only as an essential part of engineering work, but as an important aid to engineering instruction). Engng–May 15. 7500 w.

*6245. Fabrics. Aldam Heaton (Paper read before the British Arch. Assn. Pointing out the nature of the most useful fibres and the characteristics of the fabrics produced from them). Arch, Lond–May 15. 7200 w.

6280. Latest Inventions in Aerial Navigation. Rudolph Kosch (Illustrated description of a new experimental machine, designed by the author, and some results attained by it, with general remarks upon aviation). Sci Am Sup-May 30. 2800 w.

6287. On a Rotational Motion of the Cathode Disk in the Crookes Tube. Francis E. Nipher (Read before the Academy of Science of St. Louis. An account of an observation made in the use of the Crookes tube and subsequent experiments). Elec Rev-May 27. 800 w.

6299. Some Experiments with Röntgen Rays. W. C. Peckham (Successful experiments made with the object of dispensing with the fluoroscope and its use by individuals, and to show the effects to an audience, all at once). Elec Wld-May 30. 600 w.

6300. Standards of Light. Edward L. Nichols, Clayton H. Sharp, and Charles P. Matthews (Abstract of a preliminary report of the Sub-Committee of the Amer. Inst. of Elec. Engs). Elec Wld-May 30. 1000 w.

†6314. How the Great Lakes Were Built. J. W. Spencer (A geological study). Pop Sci M-June. 4800 w.

†6315. The Metric System. Herbert Spencer.—With a Letter from Sir Frederick Bramwell (An argument against the adoption of the metric system, claiming that it does not fulfill the requirements of scientific and ideal perfection). Pop Sci M-June. 7800 w.

†6351. Concerning Crookes Tubes. C. C. Hutchins and F. C. Robinson (An article proving that the making of these tubes need not be beyond the resources of the ordinary laboratory. A little skill in glass-blowing and in the manipulation of the pump is all that is required). Am Jour of Sci-June. 1300 w.

†6352. Researches on the Röntgen Rays. Alfred M. Mayer (Experiments described were made in the private laboratory of Prof. Rood in Columbia University). Am Jour of Sci-June. 3300 w.

6354. Self-Education in Gas Engineering. A. C. Humphreys (The misleading idea that special education in gas engineering will not be needed in the future is deprecated, and the lines along which such education must proceed are defined). Am Gas Lgt Jour-June 1. 12000 w.

6355. The (Alleged) Law of Inverse Squares. B. E. Chollar (This law is treated as geometrical, not physical, and its relation to the commercial value of artificial lights is considered. Practical exceptions to the operation of the law are noted. Paper criticised in discussion). Am Gas Lgt Jour-June 1. 10000 w.

6388. Röntgen Rays. D. W. Hering (A descriptive account of the means of producing these rays, and a general statement of the phenomena, with a brief review of the advances made since the first announcement of the discovery). Am Elect'n-May. 1600 w.

6389. Crookes Tubes and Experiments with Röntgen Rays. Thomas Duncan (Suggestions for the making of Crookes tubes for experiments with these rays, and the precautions necessary). Am Elect'n-May. 1500 w.

6390. A Röntgen Ray Outfit (Part first describes the construction of the induction coil, with precautions and methods. Illustrations). Am Elect'n-May. Serial. 1st part. 3000 w.

6417. Seger Cones (What is a seger cone?—Its size and shape; what it is made of; a reliable test for burning that may save hundreds of dollars—The insufficiency of all other methods). Brick-June. 1300 w.

6418. The Measurement of High Temperatures. From *La Genie Civil* (Progress and present status of the art). Sci Am Sup-June 6. 2000 w.

6422. Admission Requirements to Engineering Schools. Mark Talcott (Interesting statement of occupations of post-graduates of Worcester Polytechnic Institute). Am Mach-June 4. 700 w.

†6425. Engineering as Exhibited on the Great Lakes. John Birkinbine (General review of engineering progress in all departments in the lake region). Jour Fr Inst-June. Serial. 1st part. 5300 w.

*6451. The Joule Effect. C. E. Basevi (This phenomenon jointly investigated by Joule and Kelvin in 1852 and 1853, is discussed in its relation to liquefaction of air by the most recent processes, and is held to be inadequate to account for the results attained. A criticism of Joule's and Kelvin's experiments and an explanation of the processes is presented). Eng, Lond-May 29. 3200 w.

*6461. The Sailing Flight of Birds (An attempt to explain the sailing flight of birds by the action of lateral wind). Engng-May 29. 1000 w.

*6477. A New Computing Instrument. W. H. Schuermann (Illustrated description of a new instrument, differing from the ordinary slide-rule by the use of angular instead of rectilinear units) Eng Assn of the South-April. 2400 w.

*6487. Some Experiments with Hittorf Tubes and Röntgen Rays. Antonio Roiti (Experiments made by writer. Treats of shadows and penumbras; the behavior of a tube during exhaustion; shadows directly magnified; fluorescence does not appear to be a necessary condition for the emission of Röntgen rays; complications of phenomena and the necessity for describing minutely all the circumstances in which the observations are made; and applications to petrography). Elect'n-May 29. 3300 w.

†6499. Talks with Rubber-Men on Air-Brake Hose (A consensus of opinions of rubber men). Ind Rub Wld-June 10. 2500 w.

†6500. The Manufacture of Fabrics for Tires (Review of the fabrics used and their wear, with an account of the use of sea island cotton, which is considered the most successful). Ind Rub Wld-June 10. 1700 w.

†6502. Fire-Hose Requirements in New York City (Specifications for hose required by the city, with information regarding kind of hose used in different cities, and cost). Ind Rub Wld-June 10. 1300 w.

BOOKS OF THE MONTH

Descriptive Circulars containing full information relative to books herein named may be obtained of the publishers.

Burr, S. D. V. Bicycle Repairing. David Williams, New York. 1896. Cloth, $1.

Thorpe, T. May. What is Money? or Popular Remedies for Popular Ills. J. S. Ogilvie Pub. Co. 1896. Paper, 75c.

Frank C. Smith. American and English Corporation Cases. A Collection of Cases Affecting Corporations of Every Kind Other than Railroad and Municipal in United States, Canada and England. E. Thompson Co., Northport, N. Y. 1896. Sheep, $4 50.

Sound Currency 1895. Reform Club Sound Currency Committee. 1895. Paper, $1.

Davis, P. J. Standard, Practical Plumbing. Spon & Chamberlain. 1895–1896. Cloth, Vol. 1, $3; Vol. 2, $4.50.

Ellstaetter, K. The Indian Silver Currency. An Historical and Economic Study. Translated by J. Laurence Laughlin. The University of Chicago Press. 1895. Cloth, $1.25.

Hammel, W. C. A. Observation Blanks in Physics. American Book Co. New York. 1896. Paper, 30c.

Hanson, E. C. Practical Studies in Fermentation, Being Contributions to the Life History of Micro Organisms. Translated by A. K. Miller. Spon & Chamberlain. 1896. Cloth, $5.

Koch, Alex. Editor. Academy Architecture. New Series. Vol. 3. Supplement to Volume for 1895. Bruno Hessling. New York. 1896. Cloth, $2.50.

Kramer, Th, v. and Berehns, W. Ornamental Fragments, Scrolls, etc. Bruno Hessling. New York. 1896. Cloth, $13.50.

Lemoke, Mrs. Gesine. How to Live Well on Twenty-five Cents a Day. J. S. Ogilvie Pub. Co. New York. 1896. Paper, 25c.

Thomas, Thaddeus P. The City Government of Baltimore, Md. The Johns Hopkins Press. Baltimore, Md. 1896. Paper, 25c.

Wilcox, Lute. Irrigation Farming. Orange Judd Co. New York. 1895. Cloth, $1.50.

Cheever, Noah W. Corporation Form Book for the Organization of Private Corporations. Callaghan & Co. Chicago. 1895. Sheep, $3.50.

Callet, Harold Water Softening and Purification. Spon and Chamberlain. New York. 1896. Cloth, $2.

Del Mar, Alex. History of Monetary Systems. Brentano's. New York. 1895. Cloth, $5.

Dunn, Ja. D. Manual of Geology Treating of the Principles of the Science with Special Reference to American Geological History. American Book Co. 1895. Cloth, $5.

Eissler, M. The Metallurgy of Gold. 4th edition revised and enlarged. D. Van Nostrand Co. 1896. Cloth, $5.

Grimshaw, Robert. Shop Kinks and Machine Shop Chat. Norman W. Henly & Co. New York. 1896. Cloth, $2.50.

Hancock, Herbert. Test-book of Mechanics and Hydrostatics. D. Van Nostrand Co. 1895. Cloth, $1.75.

Howard, M. W. The American Plutocracy. Holland Publishing Co. New York. 1896. Cloth, $1. Paper, 50c.

Hunter, Robert. Editor. The Encyclopædic Dictionary. Syndicate Publishing Company. Phila. 1895. 4 vols. Cloth, $16.

Merriman, Mansfield. Text-book of the Mechanics of Materials. 6th edition revised and enlarged. John Wiley & Sons. 1895. Cloth, $4.

Petrie, W. M., Flinders. Egyptian Decorative Art. G. P. Putnam's Sons, importers. New York. 1895. Cloth, $1.25.

Rickard, T. Arthur. Professional Papers on Mining and Metallurgy read before the American Institute of Mining Engineers. Scientific Publishing Co. New York. 1896. Cloth, $2.

Rockell, Alfred Perkins. Roads and Pavements in France. John Wiley & Sons. 1895. Cloth, $1.25.

Scott, A. G. A Digest of the Mechanics' Lien Law of Illinois, with Forms. S. P. Stansbury & Co. Chicago. 1896. Paper, 25c.

Siebert, J. S., and Biggin, F. C. Modern Stone Cutting and Masonry, with Special Reference to the Making of Working Drawings. John Wiley & Sons. New York. 1896. Cloth, $1.50.

Spears, J. R. The Gold Diggings of Cape Horn. G. P. Putnam's Sons. New York. 1895. Cloth, $1.75.

Bennett, G. C. Paupers, Pauperism and Relief Giving in the United States. G. C. Bennett, New York. 1896. Paper, 15c.

Jamieson, Andrew. A Text-Book on Applied Mechanics. Specially arranged for Engineering Students. J. B. Lippincott Co., Philadelphia. 1896. Cloth, $2.50.

Jordan, C. H. Tabulated Weights of Angles, Tee and Bulb Iron and Steel. Spon and Chamberlain, New York. 1896. Cloth, 75c.

Nystrom, J. W. Pocket-Book of Mechanics and Engineering. 21st edition revised and corrected by Robert Grimshaw. J. B. Lippincott Bros., Philadelphia. 1896. Flexible covers, $3 50.

Doane, F. W. W. City Engineer, Editor. Annual Reports of the Several Departments of the Civic Government of Halifax, for the Civic Year 1894-95. Paper.

Holmes, F. M. Celebrated Mechanics and their Achievements Fleming H. Revell Co., New York and Chicago. Cloth, 75c.

Chambers, W. Mathematical Tables. Edited by James Pryde. New ed. D. Van Nostrand Co., New York. 1896. Cloth, $1.75.

Giddings, Franklin H. The Principles of Sociology. Macmillan & Co., New York. 1896. Cloth, $3.

Paterson, G. W. Lummis. The Management of Dynamos. Imported by C. Scribner's Sons, New York. 1896. Cloth, $1.40.

Nicholson, J. Shield. Strikes and Social Problems. Macmillan & Co., New York. 1896. Cloth, $1.25.

Nye, Alvan Crocker. A Collection of Scale Drawings and Sketches of Colonial Furniture. W. Helburn, New York. 1896. Half leather, $16. Cloth, portfolio, $14.

Robinson, W. The English Flower Garden. New 4th ed. Imported by C. Scribner's Sons, New York 1896. Cloth. $6.

Statham, H. H. Architecture for General Readers New cheaper ed Charles Scribner's Sons, New York. 1896. Cloth, $2.

Taggart, W. Scott. Cotton Spinning. Vol. 1. Including all processes up to the end of carding. Macmillan & Co., New York. 1896. Cloth, $1.75.

Redgrave, Gilbert R. Calcareous Cements. Imported by J. B. Lippincott Co., Philadelphia. 1896. Cloth, $3.

Sadtler, S P. A Handbook of Industrial Organic Chemistry. 2d ed. revised and enlarged. J. B. Lippincott Co., Philadelphia. 1896. Cloth, $5. Half leather, $5.50.

Sexton, A. Humboldt. An Elementary Text-Book of Metallurgy. J. B. Lippincott Co. 1896. Cloth, $2.50.

Turner, T. The Metallurgy of Iron. Imported by J B. Lippincott Co., Philadelphia. 1896. Cloth, $5.

Wegman, E. The Water Supply of the City of New York. John Wiley & Sons, New York. 1895. Cloth, $10.

Wurtz, C. Adolphe. Elements of Modern Chemistry. J B. Lippincott Co., Philadelphia. 1896. Cloth, $1.80. Sheep, $2.15.

Biddle, W. G. L. Social Regeneration. Student Publishing Co. Hartford, Conn., 1896. Cloth, $1.

Chester, A. H. Dictionary of the Names of Minerals, Including Their History and Etymology. John Wiley & Sons, N. Y. 1896. Cloth, $3.50.

Houston, Edwin J., and Kennelly, Arthur Edwin. Electromagnetism. The W. J. Johnston Co., New York. 1896. Cloth, $1.

Mason, W. P. Water Supply Considered Principally from a Sanitary Standpoint. John Wiley & Sons, N. Y. 1896. Cloth, $5.

Oldknow, Reginald, C. The Mechanism of Men of War: A Description of Machinery found in Modern Fighting Ships. Macmillan & Co., New York. 1896. Cloth, $1.50.

Rousiers, Paul de. The Labor Question in Britain; With Preface by H. De Tourville (translated by F. L. D. Herbertson). Macmillan & Co., New York. Cloth, $4.

Baker, M. N. Sewerage and Sewage Purification. D. Van Nostrand Co., New York. 1896. (Van Nostrand's Science Series, No. 18.) Boards, 50 cents.

Bowmaker, E., M. D. The Housing of the Working Classes, with Plans and Diagrams. C. Scribner's Sons, Importers, N. Y. 1896. (Social Questions of To-Day, No. 18.) Cloth, $1.

Cotterill, J. H. The Steam Engine Considered as a Thermodynamic Machine. Spon & Chamberlain, New York. 1896. Cloth, $4.50.

Cunningham, W., D. D. Modern Civilization in Some of its Economic Aspects. C. Scribner's Sons, New York. 1896. (Social Questions of To-Day, No. 17.) Cloth, $1.

Lieckfield, G. Practical Handbook on the Care and Management of Gas-Engines. Authorized Translation, and Chapter on Oil-Engines, by G. Richmond. Spon & Chamberlain, New York. 1896. Cloth, $1.

Reno, Conrad. Employers' Liability Acts. Houghton, Mifflin & Co., Boston. 1896. Cloth, $5.

Williams, C. R. Bankers' Encyclopedia. The Bankers' Encyclopedia Co., Chicago, 1896. Cloth, $6.

Birkmire, W. H. The Planning and Construction of American Theaters. John Wiley & Sons, New York. 1896. Cloth, $3.

Comey, Arthur Messinger. A Dictionary of Chemical Solubilities (Inorganic). Macmillan & Co., New York. 1896. Cloth, $5.

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P. Blakiston Son & Co., Philadelphia, Pa., U. S. A.=Catalogue of Chemical, Technological, and Scientific Books, including books on microscopy, water analysis, milk analysis, hygiene, toxicology, etc.

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Gorton & Lidgerwood Co., New York, U. S. A.=Large pamphlet principally directed to the description, illustration, and listing of the Gorton Side-Feed Boilers; but also, in large part, containing valuable information upon the subject of heating broadly. A valuable feature is the persentation of carefully considered forms for specifications for steam and hot-water heating contracts. An interesting feature is the array of first-class testimonials to the satisfaction given by the heating boilers supplied by this firm to large and small buildings in all parts of the United States.

Fourteenth Annual Catalogue of the Rose Polytechnic Institute, Terre Haute, Ind., with outline of the course of study and the plan of instruction.

B. F. Sturtevant Co., Boston, New York, Philadelphia, Chicago, U. S. A.=Book of 169 pages. A Treatise on the Principles and Application of Ventilation and Heating. Though this book partakes of the nature of a trade publication, and is properly classed as such, it nevertheless contains a large fund of up-to-date information upon the art of heating and ventilating by forced circulation, now rapidly taking front rank, in methods for buildings of more than ordinary size, as well as for dwellings of the refined character. A valuable feature of the treatise is the space devoted to illustration and description of important and successful installments of this sort, among which figure conspicuously, large manufacturing works, prisons, schools, hospitals, asylums, libraries, and other public buildings.

Marine Iron Works, Chicago, Ill., U. S. A.=Pamphlet illustrating and describing marine machinery and complete steam yachts and launches. Full, detailed information is given, enabling any one to make a judicious selection adapted to special requirements.

The Lidgerwood Manufacturing Company, New York, Boston, Chicago, U. S. A.=Pamphlet illustrating and describing the Lidgerwood Rapid Unloader, used for unloading ballast, dirt, etc., from flat cars in railroad work. A new and very useful device, which, drawn over the tops of the platforms of the cars, scrapes off and throws to one side the material placed on them, the locomotive supplying the needed power. Every railroad contractor ought to investigate the merits of this invention, claimed to be able to discharge a whole trainload of frozen clay in seven minutes.

The Dayton Globe Iron Works, Dayton, Ohio, U. S. A.=Catalogue presenting illustrated description of the New American Turbine, for which many points of superiority are claimed.

B. F. Sturtevant Co., Boston, New York, Chicago, Philadelphia, U. S. A., and London, Eng.=Illustrated Catalogue of the Sturtevant Improved Stationary and Portable Forges, Blowers, Exhausters, Blast Gates, Tuyeres, Hoods, Piping, etc. A fine catalogue.

J. F. Pease Furnace Company, Syracuse, N. Y., U. S. A.=Thirteenth Annual Catalogue illustrating and describing Combination Heaters, Steam Heaters, Hot-Water Heaters and Warm-Air Furnaces, with tables of capacities and data, and descriptions of details.

R. D. Wood & Co., Philadelphia, Pa., U. S. A. (Constructors of gas and water works)=Quarto book of 112 pages (boards). Illustrates and describes water and gas-works appliances,—a fine line,—with price lists and tabulated data. It also contains a carefully prepared essay on water supply, in which a comprehensive discussion of important practical points is comprised.

Johnson Lundell Electric Company, New York, U. S. A.=Pamphlet entitled "Solution of the Municipal Street Railway Problem," discussing broadly the disadvantage of the trolley and other contact systems for propelling street railway cars, and setting forth the advantages of the underground, hermetically sealed, and highly insulated conductor which is the basis of the system that this company is bringing into public notice, and that they claim to be the complete solution of the street railway problem.

The L. S. Starrett Company, Athol, Mass., U. S. A.=Catalogue No. 14, illustrating and describing an extensive line of fine mechanical tools, milling cutters and, other cutters, with price lists.

New York and Rosendale Cement Co., New York, U. S. A.=Circulars setting forth the desirable qualities of the "Brooklyn Bridge" brand of Rosendale hydraulic cement, and presenting a list—headed by the New York and Brooklyn Bridge,—of large public works, bridges, buildings, reservoirs, etc., in which this cement has been used.

Pemberthy Injector Co., Detroit, Mich., U. S. A.=The Pemberthy Bulletin for April. Discusses boiler explosions; a new theory of the strength of boilers; heat and steam. Hints for owners and managers of steam boilers.

D. Van Nostrand Co., New York, U. S. A.=Catalogue of books on electricity, electric light, the telephone, electro-motors, electric-telegraph, electro-metallurgy, etc.

Krotz, Allen & Kelly, Springfield, Ohio, U. S. A.=Illustrated pamphlet describing and setting forth advantages of the K. A. K. Electric System for steam railways, elevated railways, and street railways.

Case School of Applied Science, Cleveland, Ohio, 1896.=Pamphlet describing the department of mechanical engineering, with schedule of the course, and illustrated descriptions of its outfit of machinery, shops, testing laboratory, etc.

Lafayette Engineering and Electric Works, Lafayette, Ind., U. S. A.=Illustrated catalogue of Dynamos, Arc Lamps, and Electrical Specialties.

International Correspondence Schools, Scranton, Pa., U. S. A.=First number of *Journal of The International Correspondence Schools*, in which, among other interesting and instructive matter, is a table showing occupations and ages of 9,255 students.

Gates Iron Works, Chicago, Ill., U.S.A.=Catalogue No. 1, 3d edition. May, 1896. Illustrates and describes the Gates rock and ore breakers with names and code-names of parts and price list, also a list of catalogues, 1 to 10 inclusive, issued by this firm.

Rue Manufacturing Co., Philadelphia, Pa , U. S. A.=Catalogue illustrating and describing the "Little Giant," "Fixed Nozzle," and "Unique" injectors, boiler-washing and testing apparatus, etc.

The A. Lietz Co., San Francisco, Cal., U. S. A.=(a) "Manual of Modern Surveying Instruments, and other scientific instruments." Price 50 cts. (b) Pamphlet and price list illustrating and describing the cyclotomic transit.

Wm. J. Baldwin, M. E., 277 Pearl Street, New York, U. S. A.=Pamphlet on "The Separation of Grease from Exhaust Steam," illustrating and describing Baldwin's grease separator with price list and testimonials from users.

Steward and Romaine Mfg. Co , Ltd., Philadelphia, Pa., U. S. A.=Illustrated catalogue and price lists of iron and brass expansion bolts.

Follansbee Brothers Co., Pittsburg, Pa., U. S. A.=Account of the Trade-Mark Litigation Follansbee Brothers Company vs. John T. Morris and Charles F. Lane, doing business as the Morris and Lane Furnace Company in the matter of alleged infringement by the latter of the trade mark of the former, to wit, "Scott's I C Extra Coated" stamped on tin plates manufactured by the plaintiff, in the Circuit Court of the United States for the Northern District of Ohio, Eastern Division. Judgment for plaintiff.

Stow Manufacturing Co., Binghamton, N. Y., U. S. A.=Catalogue No. 6, illustrating and describing the Stow Flexible Shaft for Portable Drilling, Tapping, Reaming, etc., and tools used in connection therewith, with price lists, repair lists, and other useful information relating to this excellent shop device.

H. Channon Company, Chicago, U. S. A.= Catalogue illustrating, describing and presenting price lists of a long and extensive line of Contractors' and Railway Supplies. The extent of this line of goods may be inferred from the size of the catalogue, 246 octavo pages.

Snow Steam Pump Works, Buffalo, N. Y.= Large quarto pamphlet, entitled "Wayside Water Works." A most elegantly illustrated and printed trade publication, with engravings of pumping engines on alternate pages, the page opposite each pump engraving having a beautiful art engraving with appropriate text.

Ferracute Machine Co., Bridgeton, N. J., U.S.A.=Leaflet, infolding. A sheet illustrating and describing presses for use in manufacturing bicycles and cycle fittings, sewing machines, hardware implements, etc. Full data of sizes and capacities. The president of this company is the author of "Press-Working of Metals," a book of 276 pages, 8vo, and 433 engravings. Published and sold by John Wiley & Sons, New York. $3.

American Blower Co., Detroit, Mich., U.S.A. =Pamphlet containing illustrated descriptions and price lists of the "A. B. C." patent disc ventilating fan, and the "Cyclone" ventilating fan, manufactured by this company.

The Hoppes Mfg. Co., Springfield, Ohio, U.S.A.=Catalogue illustrating and describing the Hoppes live steam feed-water purifiers, and the Hoppes lime extracting exhaust feed-water heater, with extensive list of important establishments using these appliances, with capacities from 50 to 2500 H. P. Also table of economies secured by feed-water heating. Also table of dimensions of purifiers corresponding to different capacities.

Boston Belting Co., Boston, Mass., U. S. A., and New York.=Catalogue illustrating a long line of rubber belting, packing, hose, hose-reels, and other appliances, and a variety of other rubber goods.

C. W. Hunt Company, New York.=Elegantly printed and illustrated pamphlet entitled "Manilla Rope for Transmission and Hoisting." A brief treatise for engineers, on ropes used for the transmission of power, together with formulæ, tables, and data useful in mill engineering. Appended is a list of well-known users of "Stevedore" rope manufactured by this company.

The Jeffrey Mfg. Co., Columbus, Ohio, U. S. A.=Catalogue for 1896. Illustrating and describing the Jeffrey patented coal mining machines, drills, electric mine-locomotives, elevating and conveying machinery, and complete coal-mine equipments.

The Lunkenheimer Co., Cincinnati, Ohio, U. S. A., New York and London.=Pocket Edition Catalogue, 1896, of brass and iron valves, lubricators, and steam specialties. Illustrated descriptions and price lists.

The Phosphor Bronze Smelting Co., Philadelphia, Pa., U. S. A.=1896. Price List No. 10.

American Industrial Publication Co., Bridgeport, Conn., U.S.A.=Catalogue, 1896. Industrial, scientific, and technical publications.

The Deane Steam Pump Co., Holyoke, Mass., U. S. A.=Illustrated description of pumping plant installed by this company at Andover, Mass., with trial test and data. The vertical cross compound high duty pumping engine built by the company is the one used at Andover. The test was made March 4 of the present year, and an average higher duty than was obtained in the test up to May 14, is certified to by the superintendent of the Andover works.

The Lodge & Shipley Machine Tool Co., Cincinnatl, Ohio, U. S. A.=Illustrated, detailed descriptions of an improved line of engine lathes.

American Well Works, Aurora, Ill., U. S. A., and Dallas, Tex., U. S. A.=Statements of people using tools manufactured by this company, with price lists of steam, gas and water-pipe, including X and XX strong pipe and standard boiler tubes. Also illustrations of gas or gasoline engines.

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THE RELATIONS OF FINANCE TO INDUSTRIAL SUCCESS.

By Henry Clews.

IN considering the great subject of industrial enterprises, the first thing that naturally strikes the financier as well as the prudent man of general business is the character of the financial management of these institutions.

The absolute necessity of financial foresight has been emphasized time and time again, when concerns built up and guided by undoubted mercantile ability have had bright prospects destroyed through the lack of experienced financial management at a critical time.

The danger in a growing business lies chiefly in the temptation to expand too rapidly. There must be reason in all things, and in no case will that apply with better force than here. A strong nature and a cool head are indispensable in the case in point. The merchant or tradesman who commences on small capital, and who finds, after a time, that his executive and managing abilities are bringing in a constant accession of business, must very carefully watch the increase of liabilities ; otherwise, the time of stringency coming will find him unprepared to meet his demand obligations, and the results of perhaps many years will be swept away. His engagements must be so arranged that every one can be provided for at maturity, considering carefully also the element of possible variation or diminution of trade.

The great currency agitation of the present time calls for the utmost care and deliberation on the part of every business man. He must be careful not to rear a top-heavy structure at any time. The weight must surely fall. His notes or other obligations come due, and, if he be without means to meet them, he is forced to the wall.

The more attentively and closely this subject is examined, the more clearly does it appear that the place of financial management in the industrial organization largely determines its success or failure. The power and ability of the capital to increase are liable to be crippled in every attempt at augmentation, if the financial management is slow to perceive the requirements for this purpose. The surplus must be carefully watched, and not wasted in superfluous or personal expenses, for it is through the persistent operation of the law of aggregation working upon the surplus that the industrial concern achieves its great development and expansion.

Not the least important feature resulting from prudent, honest, and capable management is its advantage in preventing State interference, beyond the limits of salutary supervision, and its potency to leave no excuse for State control, which, in my opinion, might prove destructive of the highest aims of the legitimate Industrial, and deprive it of its greatest potentialities, either in the interest of the commonweal or the private-enterprising individual.

Too often, however, the management is faulty, the principal errors, I am inclined to think, being over-capitalization and a disinclination on the part of the management to make periodical statements of the condition. In other words, the quality of success which appears to be inherent in these quasi public concerns seems to be at the root of a great deal of their trouble, and a perpetual source of annoyance to their stockholders, and to all who happen to invest in their securities, with the exception of the favored few who are in the confidence of the secret management, and who have, therefore, generally a sure thing on a share of the usually large profits.

A large amount of this trouble would be avoided if the management were forced to make periodical statements, as national banks, railroad companies, and other quasi-public institutions are. This duty should be made mandatory, and equitably so, because such companies are given public privileges, and public obligations are implied, if not positively stated, in the contract between them and the public.

The fact that Industrials are possessed of double attributes and have functions of a public and a private nature combined opens the way to abuse of official power, and this may frequently occur with an honest purpose in view,—an intense desire to assert private independence against what may be regarded as public intermeddling with private affairs. An inability to perceive fine distinctions between obligations of this dual character, and the natural tendency in human nature to follow the selfish purpose in the first instance, may lead to official delinquency toward public interests, where the original intention was only a matter of self-assertion or a sensitive desire to stand upon personal dignity and personal rights. But, after such a habit of action has been some time indulged, it may assume a grosser aspect, in which delicacy of feeling and lofty notions of self-respect may play but little part, the change in the man's nature, or the management's nature and principles, having been wrought through an appeal to sharp avaricious propensities, finally so blunting the perceptions that he or they become incapable of drawing a distinction between *meum* and *tuum*. I have seen some very fine specimens, apparently, of worthy manhood and high principle so transformed by the seductive power of avarice that they have seemed to utterly forget the high and mighty purpose with which they set out to make an honorable career, and have entered greedily into the game of grab, ignoring all rules of rectitude and recklessly following the sentiment of the kingly maxim, "After us, the deluge."

Unfortunately, such a spirit pervades the management of many of these Industrials, and, in consequence of it, they have been viciously deflected from their true intent and purpose. This has sometimes occurred through ignorance of the end in view, forgetting that to aim at the greatest good is often the best means of attaining one's own individual benefit. But avarice is seldom capable of adapting this broad view, so that this vice is the greatest with which the Industrials have had to contend; and nothing can prevent it from invading both public and private rights, except the strong arm of the law.

I have no contention with those who hold the doctrine of moral suasion in cases of this kind, but I am now considering the practical phase of the subject, in which nothing but material correction, which appeals to the physical senses, has been found practically effective in business and social experience, and produced any tangible results. Of course, the moral sense is an important function to cultivate in maintaining the laws of society and business equity, but where this quality becomes very oblique, as in many cases of Industrial management, the ends of justice require firmer measures.

In plain terms, it is utterly useless to preach the moral law to a man who has an idea that he is doing a meritorious act in laying schemes to plunder his neighbor in a way that the latter cannot prove, the methods adopted being such as the public have been taught to think of as genuine and honest. Nor will the doctrine of passive obedience help that neighbor to assert his rights. It will only render him more liable to be victimized.

These industrial institutions, which had their real origin centuries ago in the corporations of Rome when that nation was mighty, long prior to its corruption and downfall, were organized with the purpose of conferring higher benefits upon the community and private individuals than could possibly accrue from individual effort.

Thus the corporate or industrial idea in its early conception, and when put in operation according to the present conception, was and is calculated to confer the greatest benefits on humanity that human ingenuity and energy can bestow. It is the most effective instrument for moving the forces that produce wealth and happiness—because there is no happiness in poverty, or morality in destitution, no matter what preachers may say—that has ever been discovered or invented by man. The existence of the corporation is absolutely necessary in this age of progress and development to give all other inventions a chance of exhibiting their capacity and of conferring their illimitable boons and blessings upon mankind. It enables an aggregation of individuals to put their capital and energy together, so as to act as one gigantic power, overcoming obstacles that by any other means would be inconquerable. It is the practical faith in our day that removes mountains.

But still this huge giant can be temporarily crippled, shackled, and subdued by the vile demon of avarice to which I have just referred.

The periodical examinations of the financial management of all industrial properties, on which I have frequently written, can be made so effective as to keep the plunder out of the way of the ultra-avaricious individual, or, if he shows an irresistible desire to meddle with it, to immediately suppress him by the strong arm of the law.

I admit that this treatment is suggestive of very radical measures, but that "desperate cases require desperate remedies" is a medical adage applicable to these business maladies.

Now comes the most delicate part of my task in stating these views in a public magazine through which they will reach a large and intelligent audience,—that is, to individualize. There is no use in firing bullets in the air and losing ammunition upon game beyond our range. We must cite cases in point, or our glittering generalities are like the idle wind. We must point out the very concerns in which the faulty financial management exists, or our labor is in vain. Without beating further around the bush then, a few of the most conspicuous of these are briefly termed, in the every-day language of the Stock Exchange, "Tobacco," "Leather," "Whiskey," and "Cordage."

Now, if these, and others similar to them, had originally all been put through the ordeal of a thorough investigation at their start by expert accountants, and their true financial condition laid before the public, serious losses would have been prevented from falling upon innocent and worthy people, and the corporations themselves saved from the reproaches now heaped upon them by the victims.

Some people draw a distinction between dishonest and unwise methods in the financial management of these properties. Many of the methods are unwise, though not dishonest and criminal, and ultimately wreck the property.

Among the railroad list furnishing illustrations of faulty financial methods may be cited Baltimore & Ohio, Reading, Atchison, Northern Pacific, Union Pacific, and many more. Many such properties have exhibited peculiar methods, if not delinquencies, in book-keeping, which should have been far more rigidly investigated than they were.

The recent investigation of the Refunding Committee of the Pacific Railroads at Washington last Spring brought out most remarkable evidence from one of the principal witnesses, who stated that the books connected with the construction of the road had been burned or destroyed as useless trash, involving the superfluous expense of room-rent, though they contained the record of transactions involving hundreds of millions of dollars, which record is now absolutely necessary to a fair settlement between the government and its debtors, their heirs and assigns, who promoted that stupendous enterprise and great highway of commerce. The fact also was put in evidence that a certain party in interest had testified before another committee, on a former occasion, that he was present when $54,000,000 of profits were divided equally among four partners,—himself and three others. None of the books of record containing this valuable information escaped from the flames.

Now, under a system of public examination,—as often as once a year at least, as I have frequently proposed, and by experts trained for that special purpose and having received a collegiate education as part of their preparation,—no such evidence could be destroyed.

Developments much more incredible, and extraordinary and shocking to the mind of the expert accountant of the present day, are promised in Union Pacific. The revelations in Northern Pacific would not be less amazing, and what has yet to come in Baltimore and Ohio regarding extraordinary book-keeping only Mr. Little knows.

Under proper supervision of the financial management, the so-called Industrials would be capable of fulfilling their beneficent purpose,—to cheapen production, in order that consumers may reap the larger portion of the profits, after a fair remuneration to management and shareholders.

Though it would take volumes to ventilate this subject fully, I think the matters to which I have referred, and the means of reform which I have suggested, strike at the root of some of the worst abuses pertaining to these commercial undertakings and investments, and especially to their speculative management and the manipulation of their securities. The "scoops" which have become so frequent in speculative circles, and which have brought unmerited odium on the legitimate speculation of Wall street, would hardly be possible under the surveillance of a board of expert, honest, responsible accountants, under government supervision and open to the freest criticism.

THE FALLACY OF MUNICIPAL OWNERSHIP OF FRANCHISES.

By Frank M. Loomis.

THERE is no more vexed problem, and none more generally deemed difficult of solution, than that involved in all attempts to regulate equitably the exercise of corporate franchises. The object of this article is to demonstrate, as far as may be, that the inherent difficulty lies not so much in the complexity of the problem as in the unacknowledged unwillingness of representatives of corporate interests on the one hand, and of doctrinaire reformers on the other, to do equal and exact justice to all.

Corporate greed is responsible in great measure for the growing Socialistic tendencies of the day, and is justly credited therewith exactly in the proportion that it has exacted more than a fair return on capital invested. Such exaction is not inaptly termed "robbery under the form of law." From the beginnings of civilization capitalistic greed has provoked unlawful reprisals, until now, under the guise of Socialists, the successors of Robin Hood and his merry men are heard justifying the spoliation of the rich, and insisting with ever increasing vehemence that their proposed reprisals ought to receive the sanction of law. The day of the highwayman is past, but "robbery under the form of law" survives.

This, the method by which the monopolist, the "protected" manufacturer, the over-greedy capitalist has appropriated in times past more than his just due, has now become the favorite and a most deadly weapon of offence in the hands of a misguided people. State Socialists, Populists, Single Taxers, Free Silverites, all under different banners, and ostensibly with different aims, are yet united in devotion to the creed of Robin Hood, and, like him, profess to be, and often are, actuated by the highest sense of public duty. Deeply impressed with a sense of the unjust methods by which many capitalists have accumulated large wealth, they seek in various ways to distribute this wealth, not of course in just proportion among the original producers thereof, which would be manifestly impracticable, but indiscriminately among all members of the community, most of whom clearly have no claim, legal or equitable, to any of it. This, the very apparent vice of all communistic schemes, ought to be easily apprehended, and yet is evidently not apprehended at all by their promoters.

Seemingly, it is not perceived that taking wrongfully-acquired property from the wrongful possessor thereof, and giving to another, not the owner, is not in any sense more justifiable than the original wrongful acquisition of such property; and this is not perceived, apparently, because of the whole community, rather than one or more individuals thereof, being the recipients, and supposedly the beneficiaries, under a Socialistic *régime*. It is a fundamental principle in the jurisprudence of all civilized countries that the wrongful possessor of property has good title thereto as against all but the rightful owner; and it will be assumed, rather than argued, in the progress of this discussion, that the people in their collective capacity, equally with an individual, ought to make good their title to any property in dispute, before assuming to take it from any one in whose possession it may be found.

Presumably no fault will be found with this assumption by those to whom this argument is primarily addressed,—those who more or less intelligently advocate the communal ownership of such franchises as are now controlled and operated by corporations. But these gentlemen, whose avowed intention is to reduce the rates now charged by corporations for railway transportation, light, water, fuel, telegraph and telephone service, etc., will not take kindly to a suggestion that they are advocating a scheme of legalized robbery. They are distinctively reformers,—men whose motives are absolutely above suspicion. Many of them are Christian Socialists, so-called. Most of them profess, and doubtless believe themselves to be actuated by, purely altruistic motives. They are violently opposed to what, in the phrase of the day, is termed degrading individualism, and to "selfish" competition; they advocate collectivism, and what they term coöperation, and assert it to be man's first duty to work for others rather than himself.

To characterize such men as robbers may, at first blush, seem highly presumptuous. Yet, if it be made to appear that their scheme involves a fine disregard of *meum* and *tuum*, and that their proposed benefactions are of things which are not theirs to give, the characterization may not seem so absolutely inappropriate.

To the writer the argument of these reformers seems to be lacking even in plausibility. Reasoning from the certain premise that the larger corporations are practically monopolies, and that their charges, uninfluenced and unregulated by competition, are grossly exorbitant, the inference is drawn, not that the charges ought to be regulated and limited, but that the people ought to own and share in the profits realized from the use of the corporate franchises.

This is an obvious *non sequitur*,—so obvious, indeed, that many who advocate municipal ownership, and yet are not prepared to go the whole length of the Socialistic programme, seek to justify their position by distinguishing certain municipal monopolies as "natural" in contradistinction to other monopolies which by necessary implication are classed, therefore, as unnatural or artificial. The municipal monopoly, like all others, being a corporation, or a body having semi-corporate powers, it is not, of course, contended by our would-be reformers that such monopoly is "natural" in the sense that it is not, like other monopolies, the creature of law absolutely dependent upon favorable legislation for the exercise of its functions. The argument, in effect, is simply that in a crowded city space limitations do not as easily admit of competition between rival railway, gas- and electric lighting companies, and perhaps sóme others, as in the open country. But this condition furnishes at most only an additional reason for regulating the doings of the municipal monopoly. It does not prove, or tend to prove, that a municipality cannot control effectively the exercise of a franchise within its corporate limits by the same methods that are found efficacious for the control of other monopolies, and is very far from proving that municipal ownership is the only, or the best, remedy. It is by no means contended here that there is no alternative but to submit to unrestricted corporate rule; but, before considering what the writer deems the true remedy for conceded ills, it is important to show more specifically than has yet been done that communal ownership of franchises, and operation of the plants connected therewith, are "robbery under the form of law." To this end it is not, relatively, very important to debate the justice of schemes, such as are occasionally proposed, to supplant existing corporations by establishing municipal plants and operating them without profit, or at such a small rate of profit as to make competition by the corporation impracticable. It may well be that a corporation can be robbed in this or some other like way, and to the extent that this is feasible it ought to be deprecated. But a much more important and vital aspect of this question is presented by the consideration that communal ownership and exercise of franchises has the effect of enabling the non-productive or least-producing class of the community to live on the producers. The shibboleth of all advocates of municipal ownership is "cheapness,"—a thing good in itself, but, if secured by enforced contributions from the tax-payers to the support of the "tax-eaters," as certainly robbery as were the alleged depredations of Robin Hood of old.

In this connection it becomes important to understand, first of all, that it has never been shown, and in the very nature of things never can be shown, that the public can manufacture a better article or render better service at a less cost than a private corporation or an individual capitalist. The latter are impelled by self-interest, the strongest motive known to human nature, to manufacture as cheaply as possible. On the other hand, the average office-holder is proverbially indifferent to the cost of anything which is to be paid for by a draft on the public treasury. It may be conceded that statistics all but innumerable show that gas, electricity, water, and street-railway service are oftentimes furnished to the people at a less price, and sometimes of a better quality, by the municipality than by the private corporation. But these statistics prove little or nothing as to the relative cost of production; and in many cities—like Philadelphia and Buffalo, for instance—the municipal product is far from satisfactory. A favorite method of compiling the statistics is to estimate the cost of the original investment for the municipal plant as nothing, on the theory that, when the money needed therefor is obtained from a sale of the municipal product, the charge to the people for such product, like a protective tariff, is not a tax. It is doubtful, also, whether the municipal bookkeeping on which these statistics are based takes any account of interest on investment, of repairs and renewals, of damages paid on account of accidents, or of the taxes which would have been paid to the municipality by a private corporation doing the business. It is not altogether certain, either, that the figures furnished by the employees of a city are always reliable.

But, granting for argument's sake the correctness of the statistics, they prove at most what any one in his senses would have conceded at the outstart,—*viz.*, that, with the element of profit eliminated, the product can and will be sold at less charge to the consumer than if the monopolist is left free to charge his own price.

But this is elementary, and might well have been taken for granted without resort to statistics. It may as freely be granted, and might as well be argued, that, if the Socialistic programme be carried out in its entirety, the first cost of everything to the consumer will be less than under the present industrial system. If the grocer, the butcher, the baker, the tailor, the milliner, everybody, in fact, sell their wares at cost price; if, in a word, the element of profit be eliminated,—of course the charge to the consumer is less. But if, as very frequently happens, the consumer be also a producer, and is barred from any profit, it is difficult to see how he is to gain by the change of system.

So of the community which hopes to gain an advantage from the consumption or use of cheap water, gas, fuel, or other commodity manufactured or produced without profit. What is gained in one way is lost in another.

By this, of course, is not meant that the converse of the proposition is true, in the sense that any individual member of the community has returned to him, directly or indirectly, the legitimate profits which he might make in any business which may be monopolized by the community as a whole. The vice of all communistic or semi-communistic schemes is that the least worthy, including the dependent class, are enabled thereby to live on the producer. In other words, it is "robbery under the form of law." Not simply in the abstract, not technically, but in a very substantial sense; and for the reason that the monopolies from which it is proposed to exclude private capital, and incidentally individual enterprise, comprise a very large and constantly-increasing proportionate part of human industry. This statement is true, in a very special sense, of the municipal ownership and operation of street railways, because of the vast capital and large number of persons employed, and because of the fact that practically all the non-productive class, and all the least productive, would profit by the "steal." It would be but idle, too, to attempt concealment of the fact that it is this wide-spread benefaction (so called) that lends to the scheme its chief charm to the professed altruistic reformer, whose arguments very naturally find a ready response from those who are willing to live on the fruits of others' labor. Reference has been made before to the boasted altruism of the municipal-ownership scheme, and this is the place to say plainly that it is a false pretence. There is nothing altruistic, nothing charitable, in a scheme which purposes taking by force of law from those who have and giving to those who have not,—especially when it involves no sacrifice by the would-be donors. The scheme may be collectivisim, and it certainly is Socialism, but it is as certainly *not* Christian, not "working for others" as enjoined by the author of Christianity. It may be coöperation, but it is not that voluntary co-operation which, while working primarily for self in obedience to "the first law of nature," works also for the joint good of all, constituting thereby the highest form of human endeavor.

Another objection to the communal system, which applies with special force to the municipal operation of street railways, remains yet to be stated. This objection is to the increased officialism which such a system would entail. The prospective creation of several thousand new positions in the municipal service, all of a nature peculiarly susceptible to political manipulation, is not a pleasant prospect for civil-service reformers to contemplate at a time when final victory is in sight, but not yet won. And the spoils system, as it is familiarly known, is not the only, or possibly the most objectionable, feature of an exaggerated officialism. The increased tenure enjoyed by numerous officials by virtue of statutes passed in derogation of civil-service reform principles, which prohibit their removal except upon charges and after a trial, has emboldened them to organize for the purpose of influencing legislation favorable to their interests as a class. Legislation of this character, increasing salaries, granting frequent holidays, etc., is crowded through the legislature with ever-increasing frequency each year.

The prospect of having this class of tax-eaters immeasurably augmented by adding thousands of street-railway employees to the city's pay-roll is something more than unpleasant. It presents a grave and very serious problem for the consideration of the already over-burdened tax-payers. It brings us face to face with the problem with which Germany is struggling to-day,—a country where the Socialistic idea has probably found more general acceptance than anywhere else. There everything, or almost everything, is "official." There is much law and order, and very much in the way of taxes. Personal liberty is at a discount, and the situation in this regard is getting more intolerable every year. It will be interesting to watch the working-out of the German problem from afar; but it may well be doubted whether any considerable number of Americans would willingly exchange conditions with the Germans.

This brings us directly to a consideration of the problem as Americans, which, if our traditions stand for anything, means as democrats and republicans. We hear much, in these times, of "Americanism," and, to our shame be it said, this is fast degenerating into a cant term, used without warrant to describe every shade of political belief, every new political nostrum, and by that ostentatious American, Theodore Roosevelt, even to distinguish right from wrong. We ought rather to be honest with ourselves, and, disclaiming once for all any peculiar sanctity, as a nation or a people, make good the claim to our birthright as freemen by standing up manfully for the only distinctively American principle,—equal rights for all men, special privileges or immunities for none.

It was asserted at the beginning of this argument that the inherent difficulty in solving the monopoly problem lay in the unacknowledged unwillingness of both parties to the controversy to do equal justice to all. It has been assumed throughout that the monopolist has been unjust and over-greedy, and the Socialistic solution has been deprecated as equally unjust. What, then, is meant by equal justice? It being manifestly impracticable to divide accumulated wealth in just proportion among all who once helped to produce it, the manful, the right, thing to do, instead of bemoaning what is passed and remediless, is to prevent further unjust exactions by prescribing a maximum rate of charges (varied from time to time as changed conditions may require) which shall not be exceeded by any corporation whose business is a monopoly. This must be done, if at all, by the people in their representative capacity. That it can be done, that it is absolutely practicable, admits of no question, for the all-sufficient reason that it has been done in notable instances. The experience of our sister republic, France, under universal manhood suffrage leaves no room for doubt that this plan will prove as efficacious with street-railway and other municipal corporations as with other not less "natural" monopolies, if only the controlling power be vested in the people immediately concerned, the residents of the city within whose limits the monopoly operates, instead of, as now, in the State legislature.

Municipal control, as distinguished from legislative control, and equally distinguished from municipal ownership, is the true solution of the municipal monopoly problem. It needs scarcely to be added that the warrant for the exercise of this control, different from and in excess of what can rightfully be exercised over the individual citizen, is to be found, not in any fanciful assumption that a municipal monopoly, more than any other, is "natural," but in the fact that it has been created and sustained by the special privileges granted to it by the people different from and exceeding those enjoyed by individuals.

The fear sometimes expressed by the representatives of monopoly that the people in their new-found power might be unjust, and the counter-opinion of the doctrinaire reformer that the people cannot be depended upon to assert and maintain their rights, may be dismissed as equally puerile. Evidently both of these opposing opinions cannot be right; and, as evidently, both are due to a distrust of democratic institutions as the conservator of equal rights. Blindly oblivious to the teaching of all history, ancient and modern, the extremists on both sides of this question magnify the smaller faults of democracy, overlooking the one patent, all-important fact that the golden age of every nation, the age in which the rights of the people have been best protected, and real progress made, has been contemporaneous with, if not a necessary incident to, the rise of democracy. The teachings of our forefathers, the story of our unparalleled success as a nation, point to the one conclusion, and show the path which we must tread, if we would escape the snares in which others have become entangled.

FIRST PRINCIPLES IN RAILROAD SIGNALLING.

By George H. Paine.

THE conditions which thirty years ago impelled Mr George Westinghouse toward his triumphant solution of the train-brake problems are the causes which, through the air-brake, have their effect in the Empire State, the Florida Special, the Black Diamond, and other fast expresses of the present.

In like manner, railway signalling has gone hand in hand (although, sad to say, a little behind hand) with the development of the air-brake; not by a single broad conception, but nevertheless by well-defined leaps, each of them closely identified with some remarkable gain in efficiency or increased safety in operation.

It is an interesting fact that the electro-pneumatic machine, the highest development of the art of interlocking signals and switches, is the invention of the person who invented the air-brake.

There are two distinct kinds of signalling, co-existent, but independent, on all railways. Of these *interlocking* comprises those signals that deal with trains occupying separate, but converging, tracks, and which, by an attempt to cross each other's path at the same time, would collide. Except in one or two unimportant cases, interlocking signals are always operated in connection with one or more switches, and are so arranged, mechanically, that, (*a*) no two of the signals which, if obeyed, would tend to bring trains into collision can be cleared at the same time, (*b*) all of the switches over which a train must pass are set and locked in the proper position before a clear signal can be given, and (*c*) none of the switches can be moved or even unlocked, so long as the signal which controls them remains in the clear position.

Although the practice of interlocking becomes more complicated as the demands of traffic increase, its manifestations, the signals, have been admirably simplified, until now there is but one recognized form, universally known as the *semaphore.*

The semaphore is an arm mounted on a post and pivoted at one end, so that it may rest in a horizontal position or be inclined at an angle (usually) of about 75° with the horizon. There are three kinds of semaphore,—the *home*, the *distant*, and the *dwarf.*

The home signal, Fig. 1, is used only in connection with the main tracks of a railway, and consists of an arm about five feet long mounted on a post some twenty feet above the track. A lamp is placed back of one end to illuminate it at night. When the signal is set at danger,

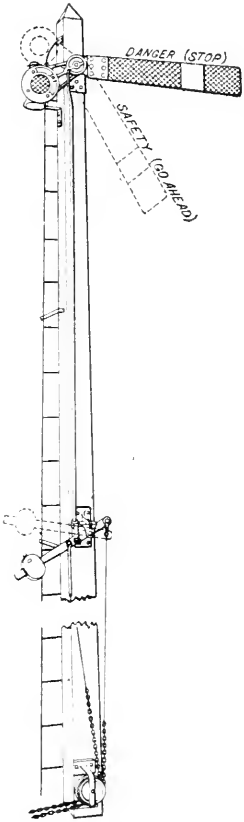


FIG. 1. HOME SIGNAL.

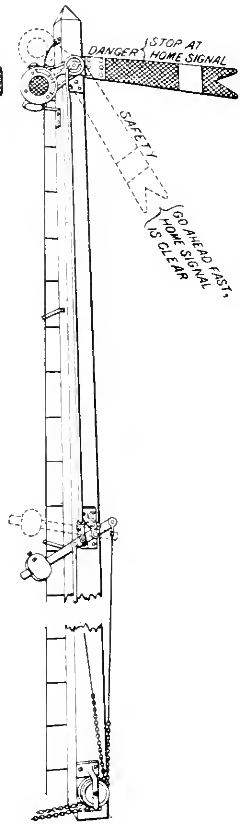


FIG. 2. DISTANT SIGNAL.

the light shines through a red glass, set in the end of the arm. When the signal is set at safety, the red glass is raised, and the light appears as white. The arm itself is usually painted red, and has a square end. The distant signal, Fig. 2, does not in itself give a positive indication, but only repeats the information rendered by the home signal, without which it cannot exist. It is of the same size as the home signal, but is usually painted green, has a "fish-tail" end, and carries a green light at night. Since its function is to repeat the information given by the home signal, it is placed from 1,200 to 2,000 feet away from it, in the direction from which trains approach. By its means, fast and heavy trains are enabled to maintain their speed up to within a certain distance from the home signal, where they receive an indication which tells them whether or not to reduce speed. It is a necessary consequence of the foregoing that the distant signal is always used in connection with main-track movements.

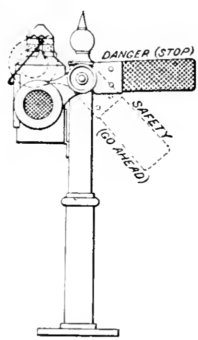


FIG. 3.
DWARF SIGNAL.

The dwarf signal, Fig. 3, like the home signal, is a stop signal. The arm is painted red and has a square end, and the night indications are the same; there the resemblance ceases, for the dwarf signal is usually not more than three feet high (often much less), has an arm but twelve inches long, and is used only on side tracks, or on main tracks where trains are running in a direction opposite to that

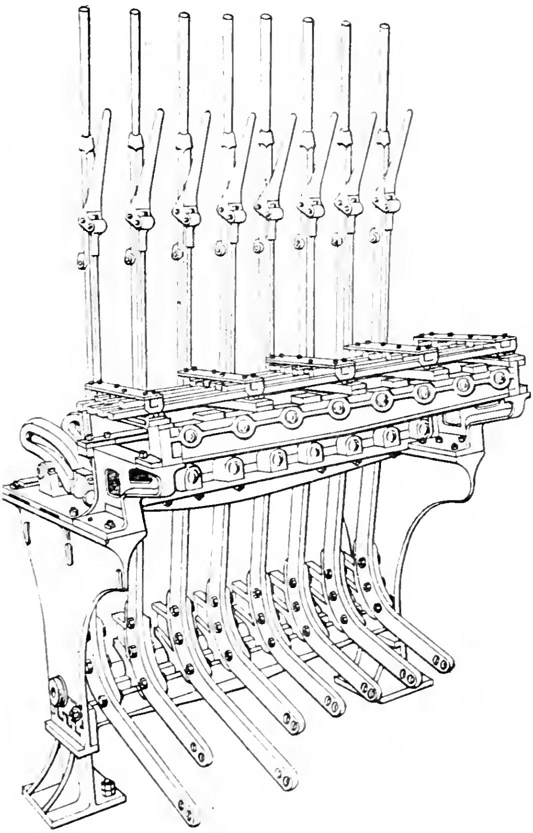


FIG. 4. MANUAL INTERLOCKING MACHINE.

which is regarded as the right one,—a thing which can occur only when there is more than one main track, for on single track trains habitually run in both directions.

These three signals are all that are used for the guidance of trains at an interlocking point. The switches and locks in the track and the signals are all connected with, controlled by, and operated from a series of levers, called a *machine*, Fig. 4, contained in a building located near the center of a plant and called the cabin, or tower. These levers are joined in a common frame and axis, and are so mechanically related by means of the *interlocking* feature proper that it is impossible for the man who moves the levers to cause a collision through the clearing of two improper signals at the same time, or to cause a derailment by means of a misplaced or unfastened switch.

In Fig. 5, W, X, Y, Z, there is illustrated the simplest form of interlocking machine. It does not contain many of the parts which are regarded as necessary in machines of the best class, but it is sufficiently complete for an explanation of the fundamental idea embodied in the term "interlocking." W is a machine of two levers, L^1 L^2, which are mounted upon a common support, S, around which, as a center, they are free to revolve, independent of each other and in a vertical plane. L^1, L^2, are connected with the cross locks, K^1, K^2, which are flat bars having indented notches in their edges opposite the

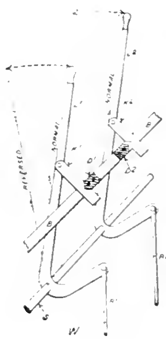


FIG. 5, W.

wedge-shaped points, D^1, D^2. D^1, D^2, are the locking dogs; they are riveted to the locking bar, B, which forces them to maintain a constant position with regard to each other. K^1, K^2, are surrounded on all four sides by guides which cause them to move in the line of their long axis, and, consequently, in the direction imparted by the movement of the lever to which each is joined. The bar, B, is placed in contact with K^1, K^2, but at right angles to them and parallel with S.

In Fig. 5, X, Y, Z, are the three positions which the levers, L^1, L^2, may hold with regard to each other when they are mutually controlled by the particular lock shown. The parts, K, B, D, are the same as in Fig. 5, W, but on a larger scale, the position of the levers being "normal" that is, forward, in W, as stated, and also in X. The object of this lock is to prevent L^1 from being "reversed" that is, pulled back, so long as L^2 is reversed, and *vice versa*. In X it is evident from the position of the notches that either K^1 or K^2 could be moved in the direction of the arrows, since B is free to move at right angles to them while they both occupy the normal position. If, now, K^2 is reversed as in Y, its notch is no longer opposite the wedge of D^2, and B is consequently held fast between K^1 and K^2 by means of D^1 and D^2, while any attempt to move K^1 (or, in other words, L^1) would prove abortive, for it is held fast by the insertion of D^1 into its notch. When, from the position X, K^1 is reversed, as in Z, K^1 forces B to move by means of its notch and the wedge on D^1; by this the wedge on D^2 is carried into the notch in K^2, which is thereby held fast in its turn. All "locks," of whatever character, are founded upon this principle, although they may take different forms and accomplish different results.

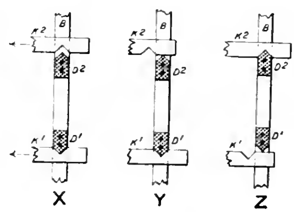
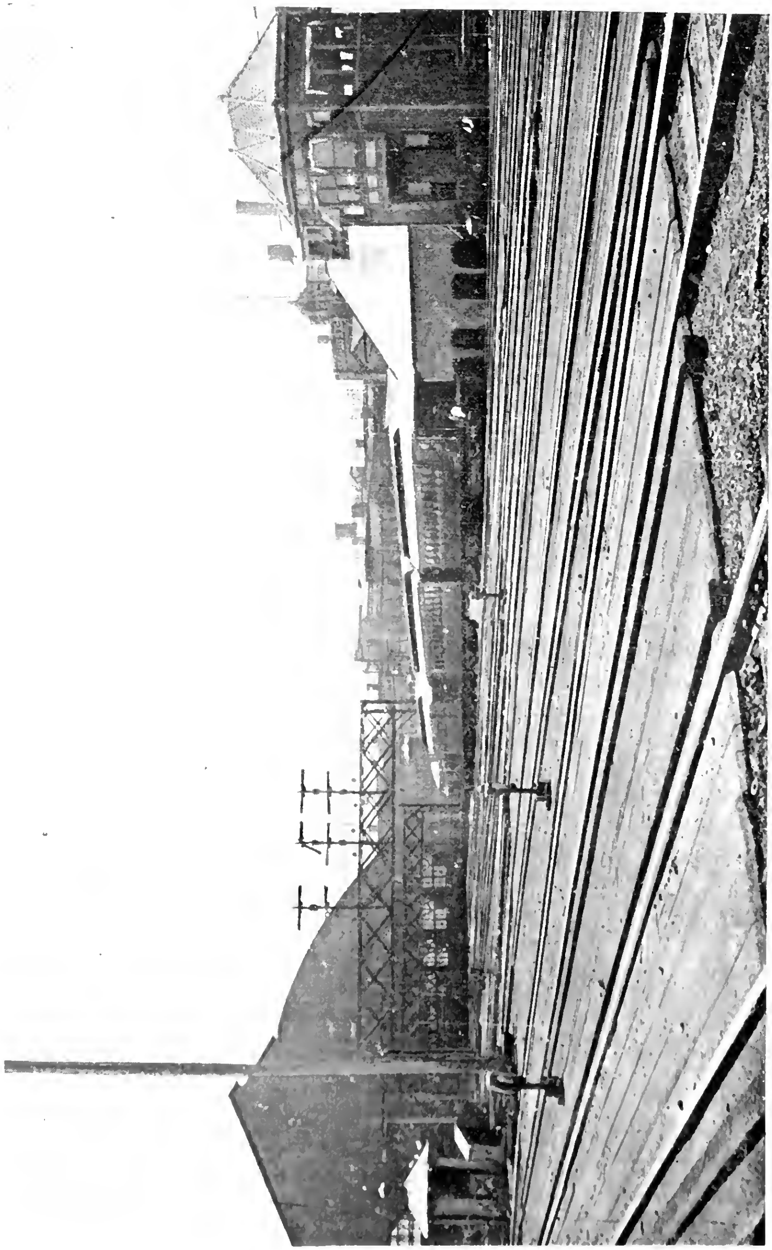


FIG. 5, X Y Z.

In Fig. 6, A, B, C, the relation which L^1, L^2, of Fig. 5, bear to a signal and a piece of track, is illustrated. Here L^1, L^2, R^1, R^2, correspond with the same letters in Fig. 5; R^1, R^2, are the rods by means of which the motion of L^1 is transmitted to F, a movable crossing frog, and the motion of L^2 to S, a signal. In A, L^1, L^2, S and F are "normal": F is set so that the track is ready for the passage of a train from O to P, but the signal S is at danger. It is, therefore, possible to reverse either L^1 or L^2, as was explained in connection



A TERMINAL STATION WITH INTERLOCKING SIGNALS. CABIN ON THE RIGHT.

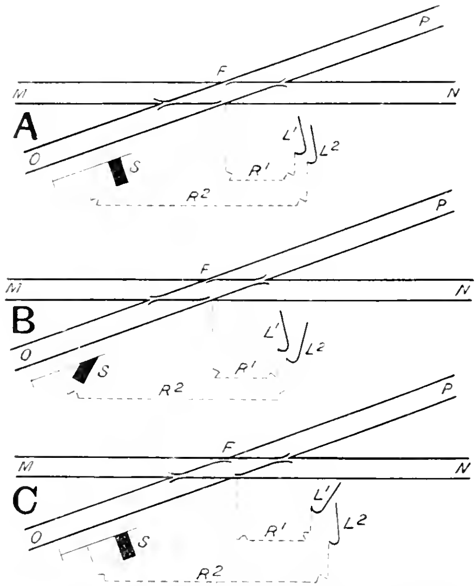
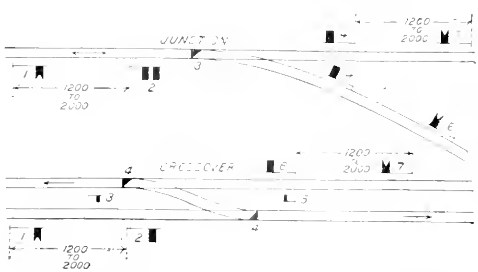


FIG. 6. RELATIONS OF LEVERS TO TRACK AND SIGNALS.

with Fig. 5, X. If, now, L^2 be reversed and the signal S be cleared, as in Fig. 6, B,—which is evidently proper, for the track is ready for a train going in that direction,—then the position of the locking will be as in Fig. 5, Y, and it will be impossible to change the position of F until L^2 has been restored to its normal position. When F has been set for a train going from M to N, as in Fig. 6, C, by the reversing of L^1, the locking on the machine will present the appearance shown in Fig. 5, Z; and, so long as that condition lasts, it is plain that neither can or should the signal S be cleared, for the track is wrong and a derailment might occur. In addition, it is likely that a train has received a clear signal to pass over the track M N, in which case a simultaneous movement past S by way of O P would cause a collision at F.

This is the service which is performed by an interlocking machine, and the means by which signal operators and engine men are prevented from making a mistake.

The applications of interlocked signals are infinite, and lie between the elementary single-track "junction" (Fig. 7) or the "cross over" (Fig. 8), and the complicated arrangement seen in Fig. 9: These sketches are the conventional way of showing at a glance the various details of an interlocking plant.



FIGS. 7 AND 8. SIMPLE INTERLOCKING PROBLEMS.

Two kinds of machine are now recognized as standard in this coun-

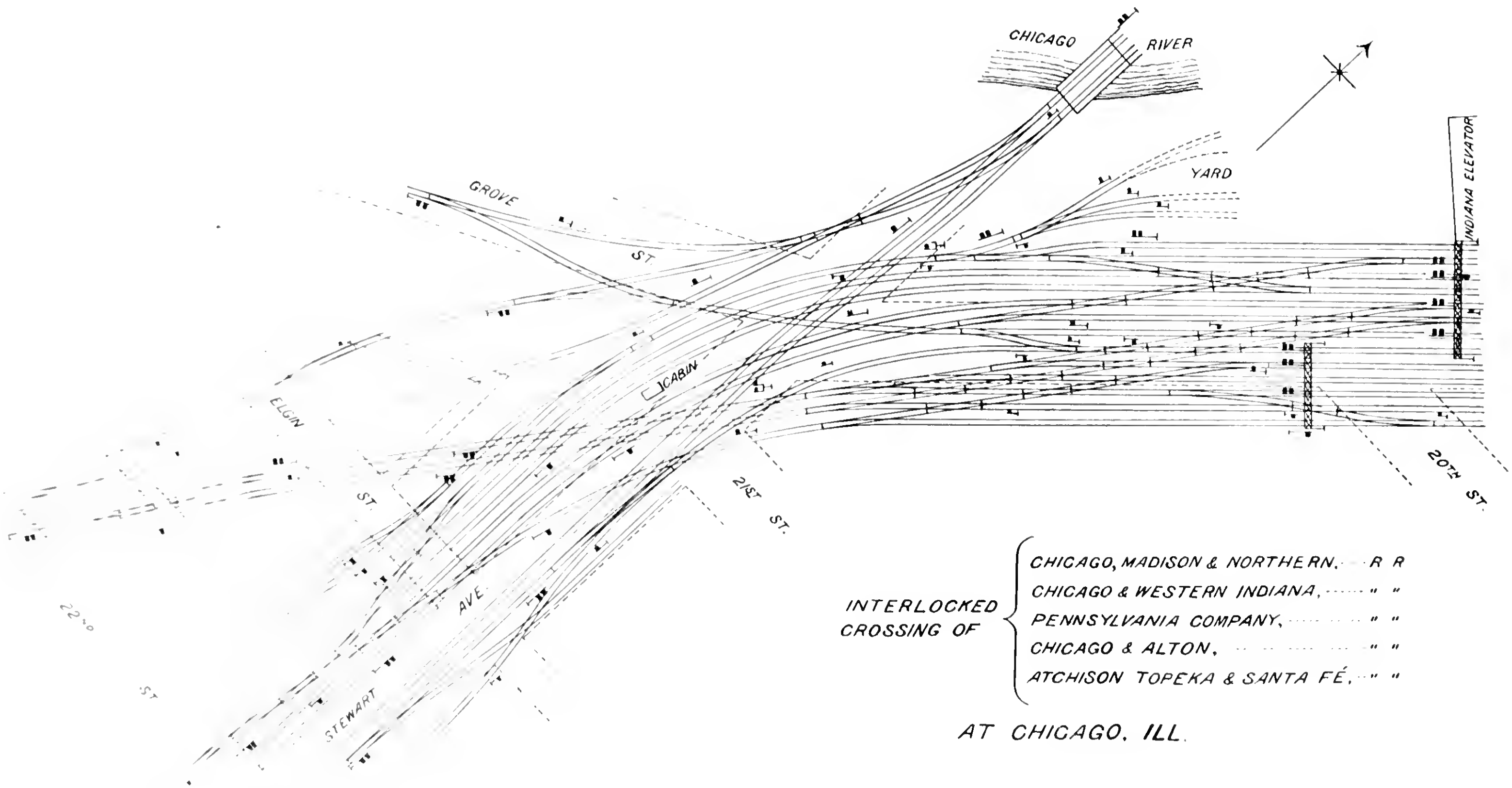


FIG. 9. A COMPLICATED CROSSING PROTECTED BY INTERLOCKING.

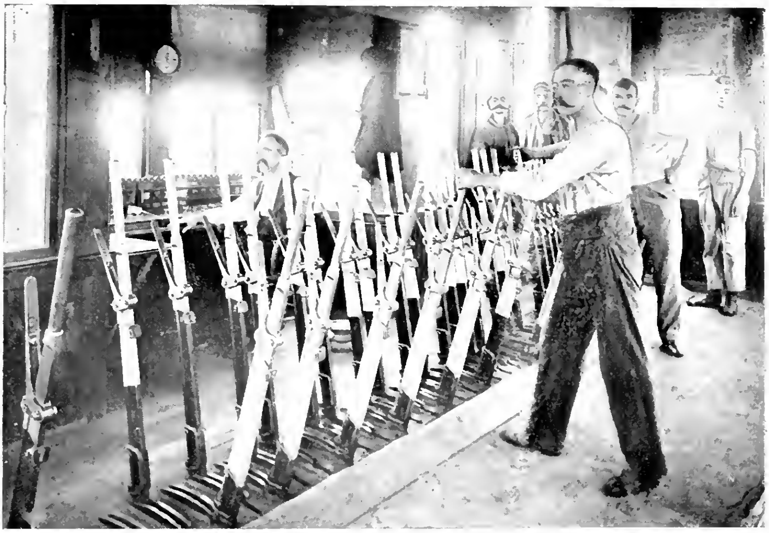
try; first and most common is the manual machine (Fig. 4), where actual man-power is used to handle the switches and signals; second, the *electro-pneumatic* machine in which, although the levers are moved by hand,—no great force being required,—the movements are performed by compressed air, and the compressed-air cylinders at the switches and signals are controlled by electro-magnets.

The levers in the manual machine are rigidly and independently connected by 1″ steel or iron (R^1, R^2, Fig. 6) pipes with the various switches, locks, and other track devices, and by pipes, or two lines of wire, with the signals. Its performance is, generally speaking, perfectly satisfactory; but, when its size passes one hundred levers or thereabout, the cost of operation becomes large. Three gangs of men are usually required in a signal cabin, each of them working eight hours: if the men receive $500 a year each, and if there are fifteen of them, the cost per year, for operators alone, in that cabin, would amount to $7,500,—not an unusual amount in plants of one hundred and fifty levers or more.

An electro-pneumatic machine, besides requiring many less levers than the manual, to accomplish a given result, enables an operator to manipulate a greater number of levers by reason of the slight effort which he need exert. One man at a time is generally enough to handle all the levers in an electro-pneumatic machine, and three men at $600 per year each—that is, $1,800—should be sufficient in all but the most exceptional cases. At all electro-pneumatic plants there must be an installation for the generation of power, consisting of boilers, engines, air-compressors, and dynamos, which increases the cost of operation, but seldom so much that in large installations the interest on the increased cost of the power over the manual plant will not be paid by the saving in operating expense, with a snug sum besides as a credit. Frequently it will be found, as, for instance, at large terminals, that nothing is required but a slight addition to the power which would be necessary in any event for lighting and heating the station, in which case the interlocking will bear only its proportion of the first cost and expense of operation, so that this part of the cost will become of still less importance in the whole scheme.

It is not now conceivable that anything will be devised which is better adapted to small isolated plants located on lines of little traffic, than a manual machine, but already it is certain that even a very small electro-pneumatic machine may be appropriate, if it forms part of a large system. Each case, however, must be decided upon its own merits, and not according to any general rule or preconceived opinion.

Curiously enough, the tendency in the United States has been to regard the claims of large and costly pieces of interlocking work almost



IN THE CABIN OF A MANUAL INTERLOCKING PLANT.

entirely to the neglect of small individual cases. Outlying cross overs, isolated switches on sharp curves where the ridiculous switch light cannot be seen more than two or three hundred feet away and the misplacing of a switch will surely cause a frightful wreck, switches at unimportant stations which are used only once a day but which are nevertheless the cause of frequent trouble, these are a few of the innumerable small matters, so far mostly ignored, which are (after the damage caused by trainmen and mistakes in telegraph orders) the origin of nearly all the horrors on a railway and yet, by a small but regular investment each year, might, on our older lines, have been entirely eliminated. Let any railway superintendent recall the number of isolated cross overs and switches on his division, determine the cost of the wrecks which have taken place at such points, and figure the cost of equipping such places with distant signals at $100 for each place, and he will be amazed to find that the expenses attending one disaster would have more than paid for total immunity.

From such small beginnings there will be a natural and healthy growth in all directions. The dependence which, it will be found, may be placed upon that silent, but untiring, sentinel, the semaphore, will gradually lead to stationing it at every dangerous and obscure place: the train men will learn that to disobey it is to endanger their own lives and the safety of their trains quite as much as if they were to ignore the presence of a red flag, frantically waved by an excited brakeman: the confidence of the officers in their men will be

A SIGNAL BRIDGE, ELECTRO-PNEUMATIC BLOCK SYSTEM.

increased, and, the real causes of disaster having been removed, the necessity for disciplinary punishment will be diminished.

But this is not all.

Where many switches must be located within a small compass, as at the entrance of a yard, there will be a palpable saving in the cost of operation, if the levers for operating them be brought together in the form of a machine, by which means one man is enabled to do the work of two or three.

The establishment of fixed signals to guard and guide the movement of trains over the switches and connecting tracks is, then, but a short step, and the surprising fact is realized that it costs less to handle the switches, colliding has become a lost art, and two switch engines are able to do the work of three under the old plan. Most surprising of all, the honest old yard-master, who has sworn all along that they would be pinned up tighter than a drum major twenty-four hours after the consecrated thing went into service, goes up into the superintendent's office after the machine has been in service a week, and says: "The cigars are on me."

It cannot be considered strange that men who have labored for a generation after a certain manner should feel a doubt as to the result of so radical a change in operating methods as is brought by the introduction of an interlocking plant. This feeling is largely due to a notion that the intercourse between the train men and those who handle the switches must be a great deal closer and more frequent than is actually necessary or desirable. In order that a leverman in a signal cabin shall perform his duties satisfactorily, he need only know the track over which each train should pass, and this knowledge is easily gained.

Sometimes it is by means of electric push-buttons, located at a distance from the cabin, which are connected with an annunciator hung directly in front of the leverman, and, on being pressed, actuate the annunciator, which registers the character and destination of each train as it approaches. At other times a telephone or telegraph instrument is used ; but, whatever the conditions, no trouble is experienced in devising a plan which will not only obviate all delays, but also secure much more rapid and certain movements than are possible where the switches are not controlled from an interlocking machine.

Block signalling, although preferably carried on by signals like those which have been described in connection with interlocking, has to do with an entirely different problem. In the matter of interlocking, generally speaking, the operations are conducted in one cabin, and the object of the mechanical arrangements is to check the errors

A HIGHWAY BRIDGE USED FOR CARRYING OVERHEAD SIGNALS.

of an individual. In block signalling it is principally intended to prevent any mistakes which might occur by carelessness or oversight in the mutual relations of two or more signalmen, situated at considerable distances from each other and in separate cabins.

While interlocking is concerned, as has been stated, with trains which are upon separate, but converging, tracks, block signalling relates only to trains which are moving upon the same track. The trains may be running in the same or in opposite directions. If in opposite directions—that is, approaching or leaving each other,—it will evidently be on single track; but, if they be running in the same direction, it may be on either single or double track, which last is a much simpler condition than the former. On double track, only trains running in the same direction need be guarded against, but on single track the question of protection is immensely complicated by having trains exposed, not only to rear collisions ("tail enders"), but to head collisions as well.

Until the more highly developed systems of block signalling are reached, the whole question is little more than a principle, an idea, and is based upon what is called the "space limit" or "space interval," which means that, if two bodies are a constant distance apart, they cannot be together and in contact. As opposed to this principle there is the "time limit" or "time interval," which, since it was born in error, nursed in ignorance, and, it is to be hoped, will soon find its death in failure, will be dismissed very shortly. The "time limit" is founded upon the belief that a train may safely leave a given point a certain number of minutes after a preceding train running in the same direction. But it is not safe for it to do so, because something may have happened to the preceding train to delay it, after it has proceeded a mile or two, and, even though the "time limit" may be half an hour, if the following train is not informed of the trouble, it will collide. This is actually what has happened, not dozens or hundreds, but thousands of times, to say nothing of the hair-breadth 'scapes. Closely allied to this is another fallacious method, which, however, has a much better excuse for its existence, and seemed to be the best at the time of its conception,—namely, "train orders," without other check than that supplied by the memory and care of the operators and despatcher. That such a plan shall be absolutely safe, there must be a guarantee that all of the men shall follow all of the rules at all times. Could this be assumed, there would be nothing to say for "blocking" trains,—that is, dividing a railway into imaginary sections called "blocks," and never permitting more than one train to occupy a certain block at any time. But, in the very nature of things, no such guarantee is possible.

It is not to supplant "train orders,"—for they must always be given in one form or another,—but as a check to these mistakes, that the block signal is most valuable, and, if properly applied, it not only is a safeguard, but increases the traffic-capacity of a piece of track.

Anything which can be seen from an engine and can be changed in its position by an operator may be used as a block signal, since its function is only to stop trains or to tell trains to go ahead. For this reason the establishment of a block system is an easy matter, and, in its simplest form, almost devoid of expense.

In Fig. 10 there is shown a piece of single track having five block stations (usually four or five miles apart, because that is the most frequent distance between railway stations on lines of moderate traffic) connected by a single telegraph or bell wire in such a way as to enable an operator in any of the cabins, A, B, C, D, E, to call up his neighbor on either hand, but not to permit any communication between the others, as, for instance, cabins A and C, or B and D. When a train approaches from X, the operator in A notifies operator B, by means of a bell code or the Morse instrument, and asks if the block A-B is clear ; B in this case would answer *yes*, upon which A would notify him that he intended sending a train into the block A-B ; B would then respond *correct*, *after* which A would clear his

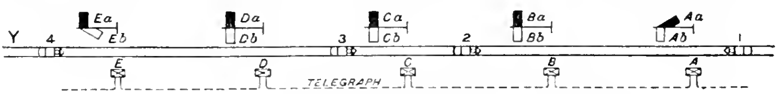


FIG. 10. TRACK EQUIPPED WITH MANUAL BLOCK SYSTEM.

signal A a, as in the drawing, permit train 1 to proceed, and immediately apprise B of the fact that it had passed his signal and entered the block. Any train, as 2, which should appear subsequently and ask for permission to enter block A-B from the opposite direction would be held at B, for both operators, A and B, would know that the block had been previously occupied, and, if one of them makes a mistake, the other will almost always detect it. In Fig. 10, the signals are semaphores, each carrying two arms, pointing in opposite directions ; the arms (black) A a, B a, etc., are for trains moving from X to Y, while the white arms are for trains moving from Y to X. The arms are painted red on the side from which the trains governed by them approach, and white on the other side ; this accounts for their different appearance on the sketch. To continue the operations : train 3, upon reaching C, is blocked, because train 2 is still occupying the block C-B, but train 4 finds a clear signal at E b, for the palpable reason that block E-D is vacant. This, the "plain manual" block system, although a vast advance upon any plan which does not have as its intention the absolute separation of trains by means of a space interval, is still open to the objection that a man who is lazy or careless, by omitting to fulfill the whole schedule of acts, in asking or giving permission for the entrance of a train to a block, may contribute to a disaster. To prevent this, a method has been devised by which to control the operations between adjoining cabins. This control is accomplished by means of electric instruments attached to the signal levers in each cabin, which are alternately locked and unlocked through the medium of a series of electric wires connecting adjoining cabins. The accuracy of these instruments is such that they entirely prevent (a) an operator from clearing his signal to admit a train, so long as a preceding train occupies the block, and (b) an operator from giving an adjoining operator permission to clear his signal more than once between the passage of any two trains. As may be conceived, collisions under this plan are almost unheard of.

Lying between plain manual blocking and controlled manual blocking is a general scheme known as "automatic blocking." Of all the methods for carrying out this idea,—and they are many,—nothing has been successful so far which did not depend upon the

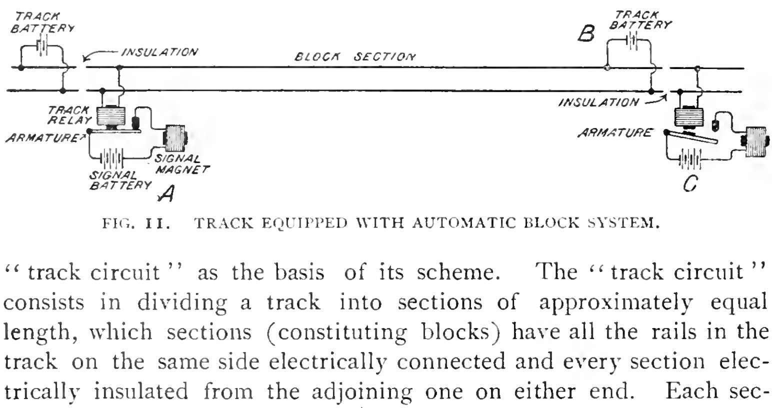


FIG. 11. TRACK EQUIPPED WITH AUTOMATIC BLOCK SYSTEM.

"track circuit" as the basis of its scheme. The "track circuit" consists in dividing a track into sections of approximately equal length, which sections (constituting blocks) have all the rails in the track on the same side electrically connected and every section electrically insulated from the adjoining one on either end. Each section has at one end a track-relay, and at the other end a track-battery, to opposite sides of which the two lines of rail are connected, much after the manner shown in Fig. 11.

A signal (not shown) is placed at the entrance to each block, and carries upon it a signal magnet. The operation is as follows. When no train is on a section, the appearance of the relay is like that at A; the current flows from one side of the track-battery B, through one line of rails, thence through the relay at A, and back again through the other line of rails to the track battery at B. By this course the track relay is magnetized, and attracts its armature, which forms part of a circuit through the signal magnet and permits that to be magnetized in turn through the signal battery, which condition results in a clear signal at A. If a train should be on the section, the appearance of the track relay is as represented at C, and is accompanied by a danger-signal. The resistance offered to the electric current through the rails, and a pair of wheels which would electrically connect the rails, is less than the resistance offered by the track relay; wherefore the current is short-circuited, and, instead of passing through the relay, goes from the battery through the rails to the first pair of wheels, crosses over through the wheel and axle, and returns through the rails on the other side of the track to the battery again, neglecting the relay altogether. In consequence of this, the armature at C is not attracted, the circuit through the signal magnet and signal battery is broken, and the signal itself, which contains signal magnet C, remains at danger.

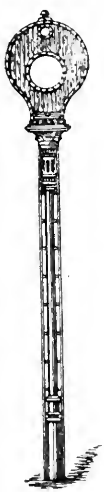


FIG. 12. BANJO SIGNAL.

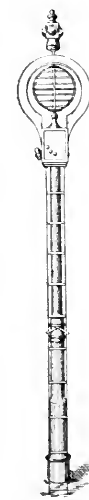


FIG. 13. BANNER SIGNAL.

There are three principal forms of signals which depend upon the track circuit for their control.

First is the "banjo" signal (Fig. 12), named from its fancied resemblance to a banjo, which has as its operating force the signal battery itself. This requires that the battery shall be somewhat more powerful than in the other two forms. The signal is an enclosed disc built of red or green cloth (for home or distant signals), which, when at danger, falls by gravity in front of the opening in the case, and, when at safety, is raised from in front of the opening, exposing a white background, as in the illustration.

The second form of automatic track-circuit signal is illustrated in Fig. 13, and is called a "banner" signal. The information is given by two discs of different forms (one for safety and one for danger), mounted at right angles to each other on the same vertical revolving shaft. This shaft is operated through a clock-work mechanism by means of a falling weight, which is alternately caught and released by the signal magnet as it is affected by the arrival and departure of trains. In Fig. 13, the signal is represented in the danger position.

The third form, the Westinghouse electro-pneumatic block system, is the only one by which the regulation semaphore may be utilized for automatic blocking. The signal post in this method bears a compressed-air cylinder, which, when filled, carries the signal arm to safety, and, when empty, allows a counter-weight to fall and the arm to assume the danger position. The admission of the pressure to the cylinder is regulated by the signal magnet (Fig. 11), the operations of which are dictated exactly as was described in the explanation of that figure.

Briefly, the first two forms of automatic signals cost more to install than any plain manual system, but their operation is much less expensive, if men must be employed solely for attendance on the manual block signals. Therefore, where the length of the blocks is less than the distance between stations, an automatic system will cause the least ultimate expense.

But a point has been reached on many lines where the switches in the main track are so frequent (and where interlocking cabins will eventually be required) that the controlled manual block system (the most costly of all, when the wages of signalmen are considered) is advisable now, since the men who are needed to throw the switches in an interlocking cabin may be utilized for operating the block signals.

What may be called the internal affairs of a railway have, so far, suffered little interference from the courts and the State legislatures (with the exception of the meddling with rates by the granger statesmen of the west), but there is an evident inclination in that direction, which is to be a growing factor in railway management. In physical matters this is so far limited to car coupler and air-brake regulation; some States also have laws requiring that an interlocking machine shall be provided wherever two railways cross each other at grade; but this is a broader matter than the term internal affairs is intended to cover, for the crossing involves two or more separate railways.

The protection, by signals, of one train from other trains on the same railway has not yet been required by law in the United States.

But it is coming.

How soon it will mature is largely dependent on the amount of signalling done voluntarily by the railways themselves. When the people are aroused by a succession of disasters, the railway interests will find themselves threatened by laws passed in response to a popular demand by ignorant demagogues or venal politicians, different in different States, conflicting and embarrassing to the last degree.

It is the change of view which is needed, and all that is needed; if it be spontaneous, so much the better. The question should not be: "Is there any way by which the use of signals may be avoided?" but: "Will signals accomplish the improvement sought?"

THE ERA OF EXTRAVAGANCE IN THE ELECTRICAL BUSINESS.

By Burton E. Greene.

WALKING up Fifth avenue in Pittsburg one day in 1886, Mr. George Westinghouse, Jr., said to one of his salesmen, who at that time had been connected with the electrical business for five years:

"What is the matter with this business? I've been in it now for six months, and have lost $40,000. Something is wrong. Everything we make is sold at a profit of from one hundred to two hundred per cent. above shop cost, and yet there is nothing left. On the contrary, we need more money all the time."

Mr. Westinghouse was neither the first nor the last to express this wonderment at a condition which must have seemed anomalous to a trained manufacturer. Yet there was little of the mysterious about the situation, and the wonderment is that the fundamental causes should not have been discovered and remedied much earlier than they were. But it is due to Mr. Westinghouse to say that he was the first one among the large manufacturers to find the weak spots, and to establish an electrical manufacturing business on lines very similar to those in vogue in the manufacture of locomotives or of wheelbarrows.

Close students of the commercial side of the electrical industry are strongly inclined to the belief that now, after sixteen years of expensive and misguided struggle, of fever and unrest, a new order of things is about to be established; that the business has touched rock bottom, and can now take its place among the stable and substantial industries of the country, affected certainly by general conditions, but offering to the investor as large returns as any other legitimate manufacturing business.

The unsatisfactory results of the past are historic facts. To make an intelligent prophecy of what the future has in store, it is necessary to review the conditions which have existed since 1879-80, and to determine whether or not the fundamental troubles have been to a sufficient degree eliminated. In making such review, it is imperative to bear in mind that the electrical business has no parallel in the history of the world. Its development has been like nothing else under the sun. It is unique, and can not, in justice, be compared to other lines of manufacture.

The writer recently asked the opinions of the four inventors upon whose work the leading pioneer companies were founded as to what were the chief reasons for the failure to make money.

Mr. Brush replied, and truly, that the company which bore his name made money, and plenty of it. He did not know anything about the affairs of the others, and had no opinions to express.

That remark suggests the chief reason why the Brush Company did make money and pay handsome dividends. They paid strict attention to their own affairs, did little experimenting after a successful arc machine had been developed, handled their sales department with energy and skill, and sailed no kites.

Mr. Edison said: "I think the chief reason was insane competition. The apparent profits attracted a horde of pirates and hangers-on, too lazy or too stupid to do original work, who devoted their time to stealing the work of the real inventors. Patents were no protection. Even if sustained ultimately, the heart had been cut out of the business, and they were not worth the cost of the litigation."

I recalled to Mr. Edison the years of delay in pushing to conclusion the trial of his most important patent,—that on the incandescent lamp,—and asked who was to blame for it. He replied:

"I suppose I was, more than any one else. We ought to have pushed that suit in 1882. But at that time we did not have an unlimited amount of money. We were building the New York lighting station, and I wanted to demonstrate that we could go underground. This cost a lot of money, and we could not raise enough to carry on the litigation at the same time. I thought the best plan was to show as quickly as possible that we had a complete and successful *system*, and leave the patent suits till we had made more money. This was probably a mistake. Such a decision as we finally got on the incandescent lamp would have made us supreme in the entire incandescent lighting field, if we had got it a few years earlier.

"People don't stop to think," said Mr. Edison, "of the enormous investment on which it was necessary to pay dividends in order to make the company, as you say, profitable. Why, it cost us over a million dollars to perfect the incandescent lamp, and, after we had done the work, the other fellows came in and took our profits.

"If I had invented a new wrench, I could have gone to the different manufacturers in that line, and got each of them to pay me a small royalty, which in the aggregate would have been a nice income. They would have made money also, and the profits would not have been big enough to tempt an army of adventurers to come into the same line. But the production of a system which revolutionized the lighting of the world opened an attractive field, and what ought to have been a gold mine for a few turned out to be at best only moderately profitable."

Prof. Thomson attributes the partial failure of so many of the larger companies to make money to the rapid growth of the business, compelling the continual enlargement of the investment. Even if money was made, it could not be distributed.

Mr. Edward Weston is inclined to be rather severe in his criticisms of the commercial management of the early companies, forgetting that some of the inventors on whom the commercial men had to rely often spent a great deal of money and wasted valuable time in the endeavor to perfect apparatus built on lines which have been proved to be absolutely wrong.

The faults of early management did not lie exclusively either with the technical men or with the financial management. The errors of judgment were many, and are not difficult to see—after it is all over.

Probably one of the greatest drawbacks to commercial success was patent litigation. It is known that in one year three of the leading companies spent $1,500,000 in this direction, or five per cent. on their entire capital stock. A score of law firms could be named who devoted most of their time for sixteen years to electrical patent litigation. They have waxed rich.

And beyond the severe drain on the finances of the companies caused by this campaign of litigation, there was the more serious waste of energy, which should have been expended solely in developing new ideas and extending the field of operation. Many of the most profitable and promising lines of development, such as the application of electric motors to machine practice, transmission of power, etc., were not taken up in earnest till quite recently.

How futile this continued and expensive struggle over patents has proved the world knows. One can count on the fingers of one's hands the patents which have been sustained, and on one hand those which have returned to their owners a royalty which made their winning worth the while.

It is easy to say that all this result should have been foreseen. It was *not* foreseen; and the men who were the most interested are entitled to rank in the first class of America's business men.

There is also to be taken into account the remarkably rapid development of apparatus, the almost daily introduction of new devices displacing everything else in the line by their superiority. It is not too much to say that millions have been wasted or lost in this way. It has been nothing unusual to see $500,000 worth of obsolete apparatus in some of the larger factories. This development was, perhaps, most conspicuous in the railway field. It is now less than ten years since this branch of work began to attract serious attention. Every year has produced something far superior to that of the year before. The standard apparatus of January has ofttimes become antique by December, and the stock been relegated to the scrap-heap.

In lighting apparatus the changes have been only slightly less marked. If I recollect correctly, only belted machines were sold up to 1892. Now one finds few chances to sell anything except direct-connected apparatus.

In fact, if we look over any lighting or railway system carefully, we find there is scarcely a detail which has not been through a half-dozen remodellings in ten years. A bright exception is the incandescent lamp itself, which is to-day, save in refinements of manufacture, just what it was in 1880.

Any manufacturer knows that these revolutionary changes in types mean money lost. The aggregate in sixteen years is almost beyond conception. Even in small supplies, it has been a very serious matter. Dead stock has been the cause of more than one failure, and goods bought with the best of judgment have become dead stock almost in the twinkling of an eye.

Closely allied to the subject of obsolete apparatus is that of experiment and research,—the continued striving for something better. In some of the companies the charges for this department have been from $100,000 to $300,000 per year. Could this expense have been avoided? It is not easy to see how. The company which rested on its oars would have been outstripped in the race in a few months. Indeed, those who were unable to raise money to keep up their experimental work came speedily to a disastrous end.

Another direction in which there was profligate waste and extravagance was in the high salaries paid,—salaries out of all proportion to the commercial value that the men receiving them would have enjoyed if engaged in any other trade. This was partially unavoidable, from the fact that men who knew anything of the science were scarce. For a great many years the business grew so rapidly that the competition for men of any degree of knowledge was intensely keen. Many who had never been able to earn more than a $2,500 salary elsewhere found themselves in demand at three times that figure. With the salaries the whole scale of expenses grew in proportion. The heads of the companies thought they were doing business at a handsome profit, and it was a long time before they appeared to realize that economical management was essential to turn the profits into money in bank. On the salary-lists were scores of "experts" who did no work except to assist the patent attorneys; in no sense were they producers. The prodigality with which money was spent at electrical gatherings would have led a stranger to suppose that each one present had the income of a Rockefeller. Extravagance was in the air.

The salesmen, no doubt, honestly believed that they were earning their large salaries, and that the companies were making money. A generator on which shop cost was given to them at $1,000 would be sold at $2,500 or even $3,000. Certainly this looked profitable. Where did the margin go? To start with, travelling expenses were enormous. Trips were long, and possible sales few in number. And when a plant was sold 1,000 or 2,000 miles away from the home office, there were the expenses, not only of the salesmen, but of a small corps of engineers to instal the plant and leave it in actual operation. One case occurs to me in the west where a plant was sold for $1,200, and the expense accounts of the salesmen and engineers on that job aggregated over $1,300. In many cases, of course, the expenses were incurred, and the other fellow got the job.

The chief causes for the acknowledged unsatisfactory results have been outlined. Criticism should be tempered with charity. Possibilities of development and discovery were so great that even the most conservative were dazzled. The problems of economical manufacture received scant attention. The entire energy of the executive departments was expended in exploring new fields,—booming the industry. That this was done in a masterly manner is attested by the fact that scarcely a hamlet remains in the country without an electric-light plant, by the passing of the horse-car and the all but universal adoption of the trolley.

So much for what has been. What has the near future in store? What hope is now held out to the investor by the situation as it is to-day? Has the turning-point been reached?

No one who has followed closely the events of the past four years can doubt that the revolution is well-nigh accomplished, and that the electrical industry is now ready to take rank among the most solid, conservative, and profitable in America or any other country. The lessons have been expensive, and thoroughly learned.

The patent agreement reached by the leading companies has put an effectual stop to further waste in this line. There will be a saving of hundreds of thousands a year, and the heads of the companies will have more time to devote to actual commercial work.

Continued or radical departures from present types of apparatus are no longer to be feared. Systems are to-day practically standardized. The huge multipolar direct-connected machines are the most efficient producers of power known to mechanics, and there is no likelihood of vital changes. And, if Tesla or any other genius shall produce a machine to give us electricity direct from coal, the electrical industry as a whole would be the surest and largest gainer. Of course, the ultimate of development has not yet been reached, but further progress is bound to be in the direction of perfecting present types. High-speed electric locomotives will be built. They will not displace present-day street-car equipments, for the limit of speed allowable on public thoroughfares is much below the possibilities of the apparatus of to-day, which has an efficiency of over ninety per cent.

In the lighting field there is great activity and much newspaper talk of the "New Light." The problems are not yet solved, and when they are, established manufacturing companies will be the first gainers.

Neither Edison or Tesla has yet claimed any such thing as a revolution from their work in this line.

Mr. Edison was recently asked by an enthusiastic and excitable young man: "Will you have your new lamp on sale next week?" The reply was: "It took me five years and cost a million of money to perfect the incandescent lighting system. It may take as long, or perhaps even longer, to make a commercial system on the lines in which I am now experimenting. The results so far achieved have been surprising and intensely interesting. Something practical may be discovered any day, but the apple is not ripe yet,—at least, not in my laboratory."

It is evident from the recent report of the committee of the American Institute of Electrical Engineers, which investigated and made tests of the etheric lighting system of Mr. D. McFarlan Moore, another worker in this field, that at present his system is more than four times as expensive as incandescent lighting.

Mr. Tesla is working on distinct lines, and has not yet taken the public into his confidence sufficiently to warrant any positive statements as to the results attained in the last few months. This much he has said: "I have gotten rid of my vibrator and the expensive coil which produced the effects shown in my St. Louis lecture in 1893. My apparatus is much simplified, and I shall lay the results of my advances before some scientific body the coming fall."

Tesla himself is very reticent about the newest developments in his laboratory. He has made no sensational claims, and, if he were an owner of any gas or electric-lighting company's stock, would surely hold it for a year or two more.

No *danger* to present investments need be looked for from this direction. Final announcement of the commercialization of etheric lighting will be welcomed by no one more heartily than by our large electrical manufacturing and lighting companies.

Expenses for experimental work have not been entirely eliminated. They never can or ought to be eliminated from any progressive trade depending upon invention for supremacy. But they have been reduced to less than one-tenth of the average of ten years ago.

Extravagant salaries are no longer common. They have been very generally adjusted to meet changed conditions. There is no longer a scarcity of men with a knowledge of electrics. In fact, the market is becoming overcrowded. All along the line sensible economies have been put into practice, and the expenses of doing business are nearly as low as in any of the old established industries. District managers, and district offices, which were in reality so many distinct business establishments where extravagance reigned supreme, have been abolished, without any great diminution in sales.

Comparing the present situation with any other period since 1880, there is nothing but encouragement for those engaged in electrical manufacture. They are offering for sale what the public must buy. The demand is as certain as the demand for ploughs or farm-wagons. The boom period has passed forever. The industry will no longer suffer from so many diseases peculiar to itself. It will thrive as general business thrives, and be less susceptible, perhaps, to a general depression than almost any other.

The chief danger to-day is that which threatens alike every commercial enterprise in America, from the railroads to the farmer, even to the individual laborer,—the danger of an unsettled financial policy. Of the ultimate triumph of the gold standard there can be no question. Meantime the evidence of financial heresy spreading through large sections of our country cannot be ignored.

With this question finally settled, the profitableness of the electrical trade would be beyond question.

THE ARCHITECTURE OF BRIDGE-BUILDING.

By E. C. Gardner.

THE formal title of the man who probably exerts a greater influence in the civilized world at the present time than any other human being, the title inherited from almost a score of centuries of predecessors, is The Supreme Bridge-Builder,—Pontifex Maximus. The ancient Romans, with whom this dignified appellation originated, held bridges in so high esteem for their service to mankind that they invested them with a distinctly religious character; they were founded by religious orders and dedicated with religious ceremonies, and the important ones were in charge of priests. In later centuries they ranked among works of philanthropy and benevolence, and the names of their founders and designers were honored and preserved among the benefactors of mankind.

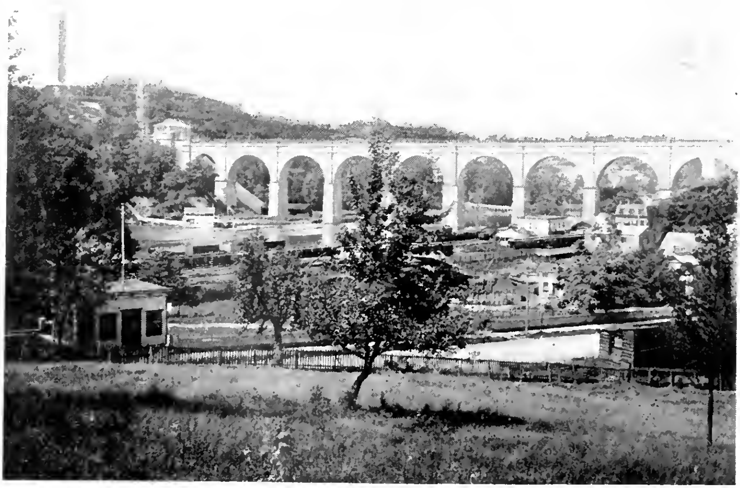
It is the aim of this paper, not to consider the principles of construction involved in this most indispensable of all modern engineering work, but to suggest certain considerations relating to their visible design,—to what, for convenience, might be called their architectural rather than engineering characteristics.

ANCIENT AQUEDUCT NEAR ROME.

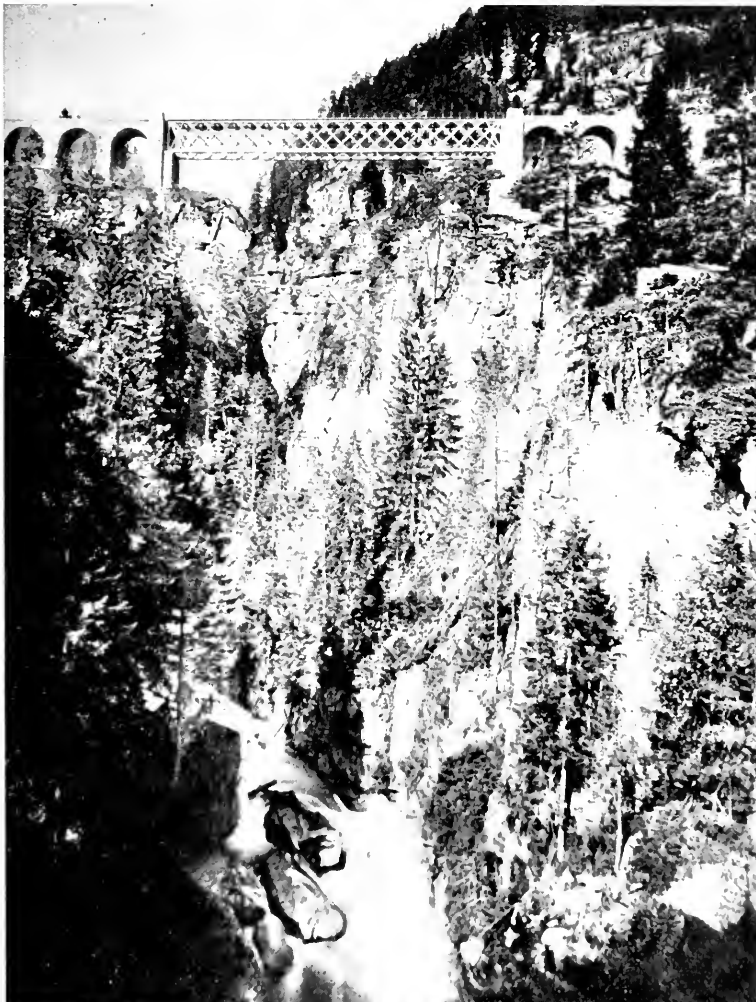
BRIDGE ON THE VIA FLAMINIA, PORTO DEL POPOLO, ROME.

SHOGUN'S BRIDGE, JAPAN.

From the rustic pathway that carries a forest trail across a mountain brook, to the gigantic viaduct that spans an arm of the sea, bearing railway trains above the tallest masts of the steam-ships, bridges



HIGH BRIDGE, NEW YORK.



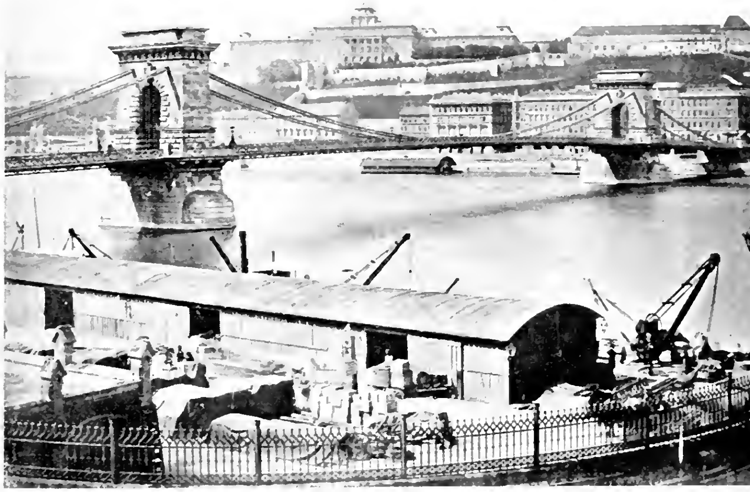
THE UPPER BRIDGE, ST. GOTHARD, SWITZERLAND.

have a natural right to be reckoned among the most interesting and beautiful of all artificial structures. Nowhere are nature and the arts of building brought into more intimate relations; nowhere does nature more generously respond to our attempts to make our work harmonize with hers.

Man is a travelling animal: when the way is not open, he prepares a way for himself. If there are mountains in his track, he bores through them ; forests he cuts down. He sails across the ocean, and bridges the gulfs and rivers. We Americans have also inherited from many generations of restless ancestors what might be called an anticipation of change,—always for the better, of course, but inevitable. We take it for granted that we shall tear down in a few years and build bigger ; that we shall move on for the sake of greater prosperity : go west for more room to grow. But there are disadvantages in having too large a country and in being too large for our age. In the effort to meet the growing demands upon our resources, to take actual possession of our heritage, we do many things for immediate use rather than for lasting service,—with more regard for quantity than for quality, and with a sort of frivolous frailty that is sometimes the most satisfactory thing about our work. If we must have monstrosities in the way of buildings, public and private, let us be thankful that they are rarely fire-proof.

To the pioneer who does not even know that he shall ever retrace his steps, a fallen tree or a rope of twisted grass suffices to span a gulf or stream ; and, for the railroad that must at the hazard of its own life reach a distant point before some competing line has drawn travel and population in another direction, a wooden trestle that creaks and sways under its train of cars laden with foreign emigrants and other crude but valuable ore is all we have time or money to provide. We cannot stand upon the order of our going, but must go at once. Undoubtedly this spirit of enterprise, to call it by its best name, accounts

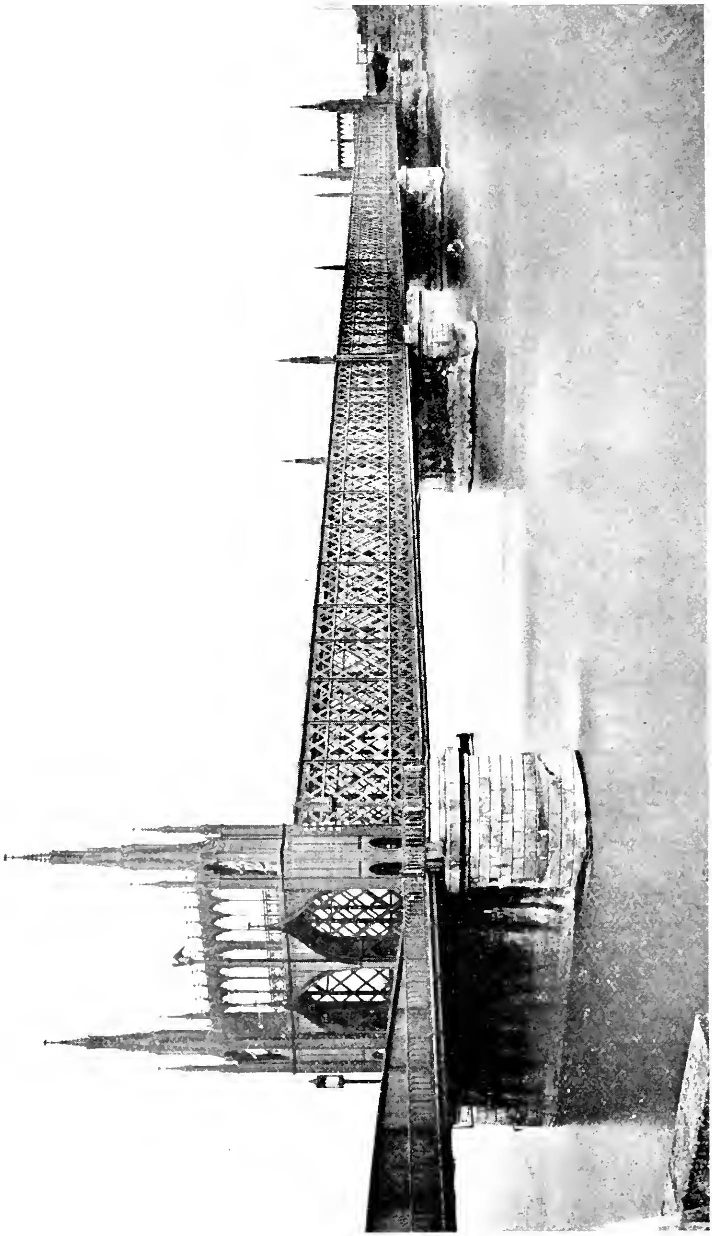
BRIDGE AT VIENNA.



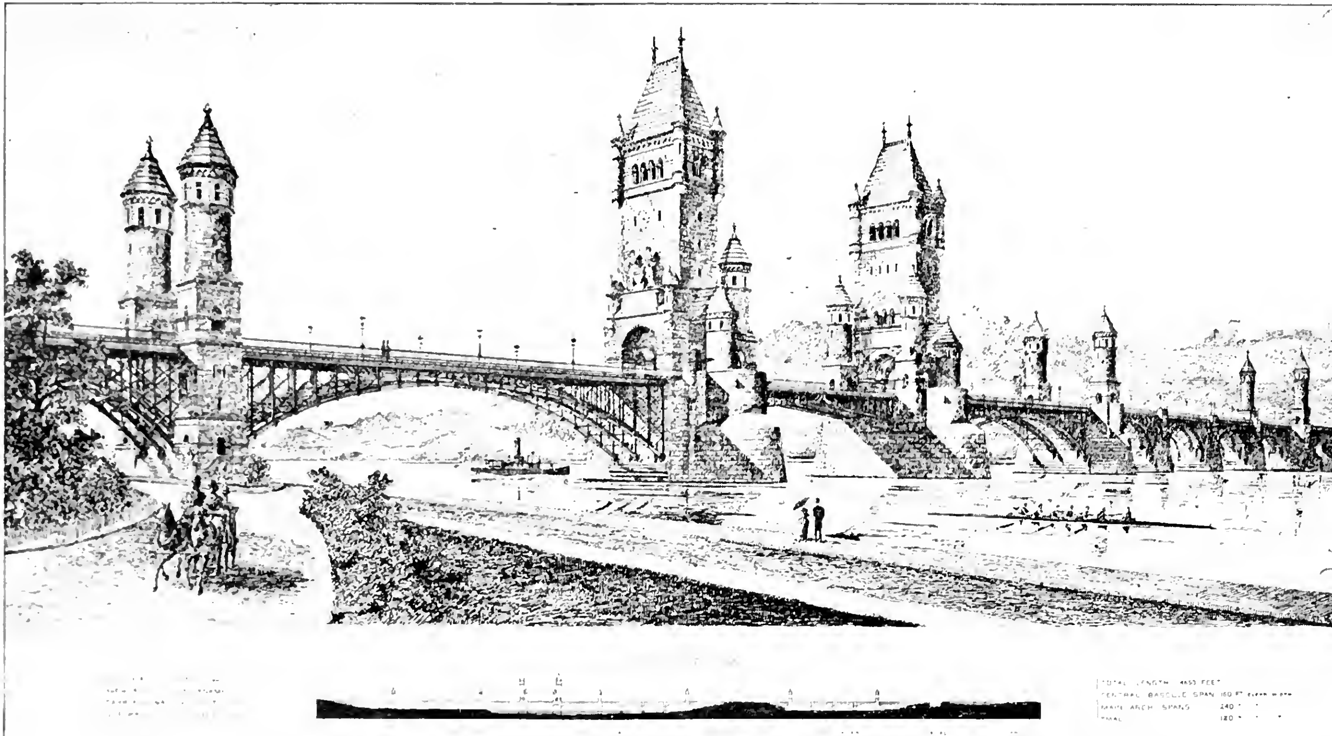
SUSPENSION BRIDGE AT VIENNA.

for much of our cheap and unsatisfactory work in many directions.

But we are growing older and wiser; we are learning that it pays to be thorough; we are beginning to understand that, the more permanent our work, the more imperative is the obligation that it should bear visible evidence of the trained skill and earnest thought by which alone the lasting quality of artistic excellence is achieved. Broadly speaking, it is true that whatever is made on the lines of strict economy and utility will be beautiful. If the contrary appears to be the case, it is time to question the correctness of our ideas of beauty and the soundness of the principles on which our economy and utility are supposed to be based. To an educated mechanic there is great beauty in a steel truss in which perfect compliance with mathematical law is apparent, and equally conspicuous ugliness when these principles are violated. But he would be a dogmatic engineer who should say that there is but one right way in which the materials that form the girders of a steel bridge can be disposed. He would be an incompetent engineer who should say that, in choosing between the forms that lie strictly within the lines of utility and economy, beauty may not also be sought and found. Suspension bridges cannot easily avoid being beautiful in the lines of their essential construction, but, aside from these, the distinctly artistic element of steel bridges, speaking in paradox, is to be sought in their supports and approaches,—that is, in the masonry of the piers and abutments on which they rest. These,



BRIDGE AT STRASBURG.

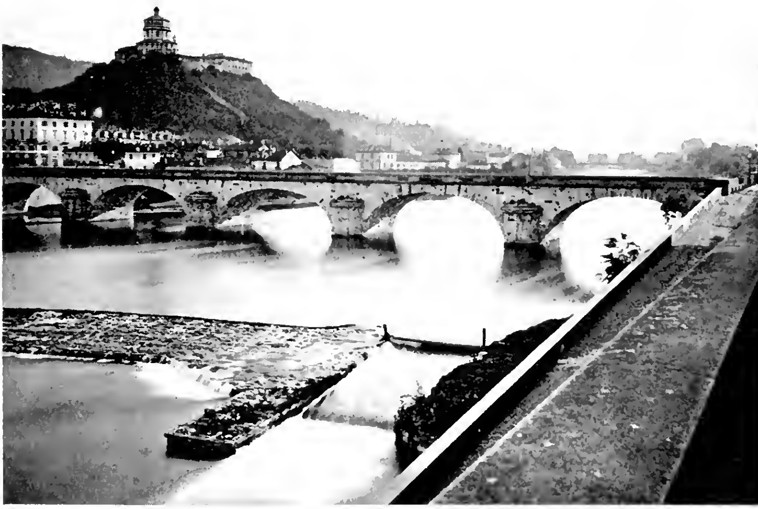


PROPOSED GRANT MEMORIAL BRIDGE ACROSS THE POTOMAC AT WASHINGTON. SMITHMEYER & PELZ, ARCHITECTS.

which must first have strength and durability, also afford ample opportunity for grace and elegance of form, and, in large structures, for dignity and grandeur of proportion: while, in conspicuous places, richness of material and a high degree of decoration are as appropriate and desirable as in any other public or private building.

It is one of the striking incongruities in the work of our great railway corporations that they will spend lavishly upon the exteriors of their stations in large cities,—stations often located on subordinate streets,—while over main avenues or popular thoroughfares the viaduct, which might be a perpetual object-lesson of beautiful architectural design, of scientific construction, and, if they please to consider it from that point of view, a perennial advertisement of the wisdom and taste of the corporation,—this viaduct is made with the apparent indifference to external appearance that might characterize the scaffoldings or derricks temporarily erected for the destruction of a disused store-house. The façades of the business blocks that border the street are by no means as conspicuous as the structure that carries the trains across it, for this of necessity is visible,—often obtrusively and obstructively so for a long distance in either direction. Indeed, it is beyond argument that a permanent structure in such a position should possess the highest degree of architectural beauty: otherwise it is an impertinence and a gross violation of the unwritten law that enjoins

BOSTON AND ALBANY RAILROAD BRIDGE, SPRINGFIELD, MASS.

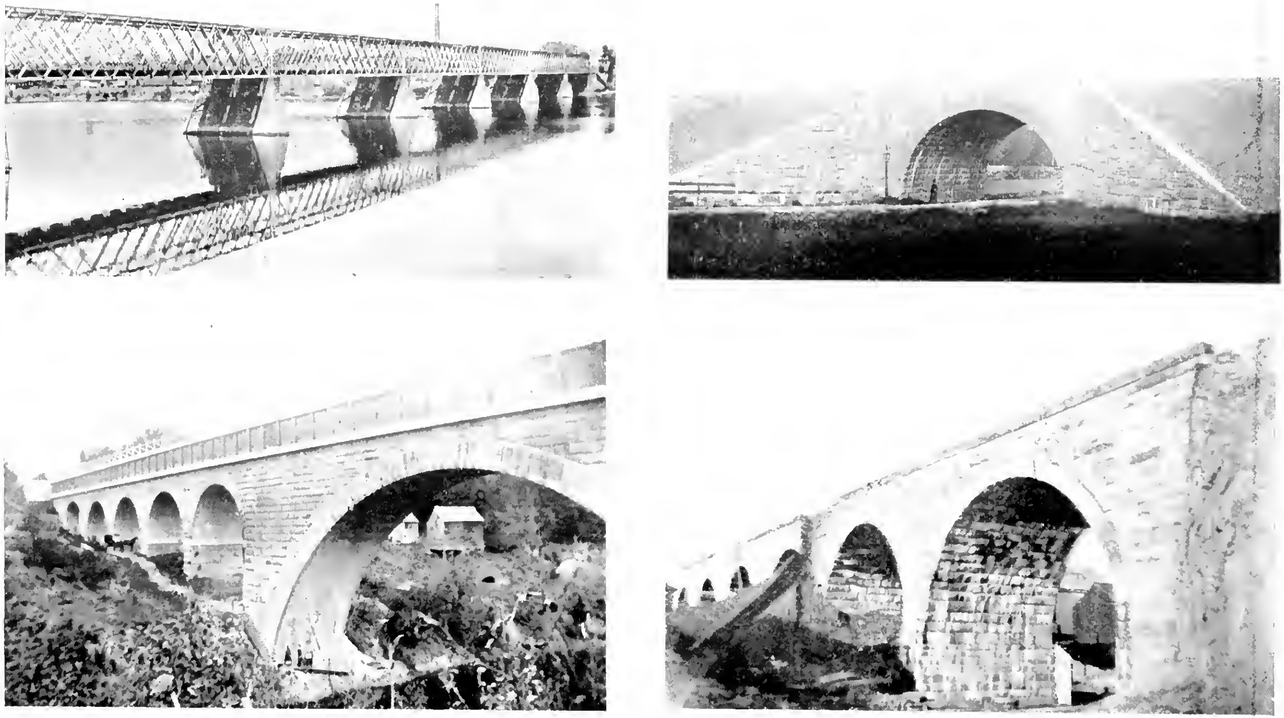


BRIDGE OVER THE PO, TURIN, ITALY.

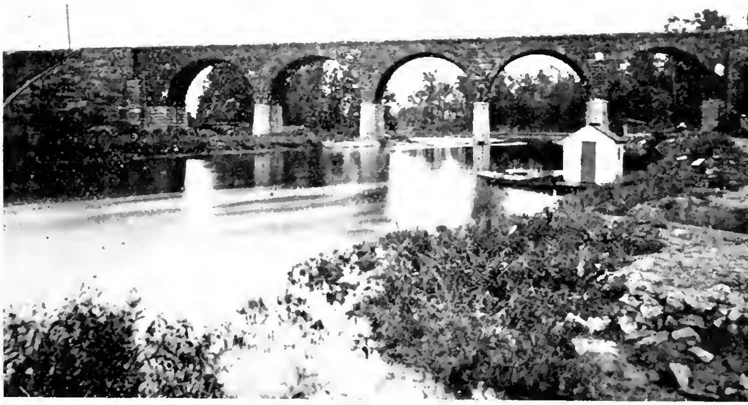
corporations to treat the public with at least an outward show of respect.

Of railroad bridges in the open country it needs to be said only that there should be enough of them to prevent grade crossings of highways. But, when they are actually within towns or cities, or so near them that they are likely to be surrounded by the cities' growth, their appearance should correspond, not with their present surroundings, which may be in a transition state, but rather with their probable environment in the future. For, of all substantial structures, bridges are the most immovable. Churches are torn down to make way for commerce ; schools change with changing methods of education ; one kind of business crowds out another ; even prisons and poor-houses are passed along by the surges of population ; but the great thoroughfares of travel, once established, are inflexibly conservative, and all that is visible in their construction should possess the qualities that entitle them to respect and admiration.

The new State highways which, happily, are beginning to crawl across the country, binding it more firmly together and giving added strength to its institutions, should be models of thoroughness. This, for most, if not for all, minor streams, means bridges of masonry ; for the wider spans, a combination of masonry and steel. Arches of brick



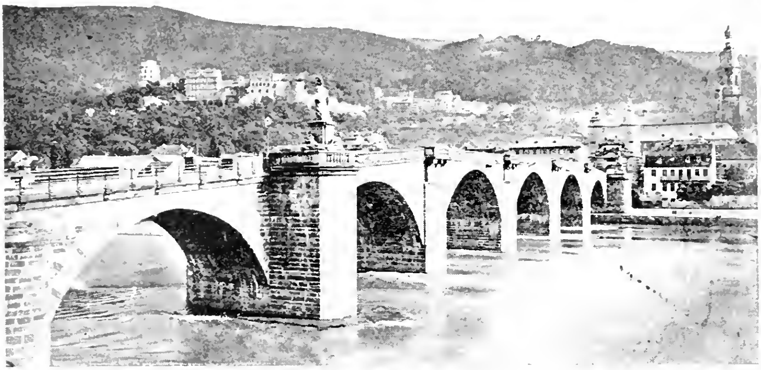
SOME BRIDGES OF THE BOSTON AND ALBANY RAILROAD.



BIG CONESTOGA CREEK BRIDGE.

ON THE LITTLE CONEMAUGH RIVER.

TWO BRIDGES ON THE PENNSYLVANIA RAILROAD.



BRIDGE AT HEIDELBERG, GERMANY.

and stone are by no means as difficult of attainment as is commonly supposed. Undoubtedly iron and steel are handled with far greater skill and economy than they were a few years ago, but the use of stone, bricks, cement, and other forms of artificial masonry has been modified and improved in scarcely less degree, and it is true in many cases

BRIDGE AT PISA, ITALY.

that a skilfully-constructed arch would cost but little, if any, more than the necessary buttresses for the support of an iron or wooden girder. It is certain that the rivers will never cease to run,—certainly not this side of the Rocky mountains. It is almost equally certain that the stream of human travel will follow the same lines that are now established, as long as our civilization endures, and there is no excuse for temporizing in the building of its channel.

There is no artificial structure that more readily admits of a satisfactory combination of the practical with the sentimental, using the latter word in its legitimate sense,—that is, as the visible expression of a worthy sentiment. We have memorial churches, halls, towers, and fountains, but from the permanence and constancy of their service,

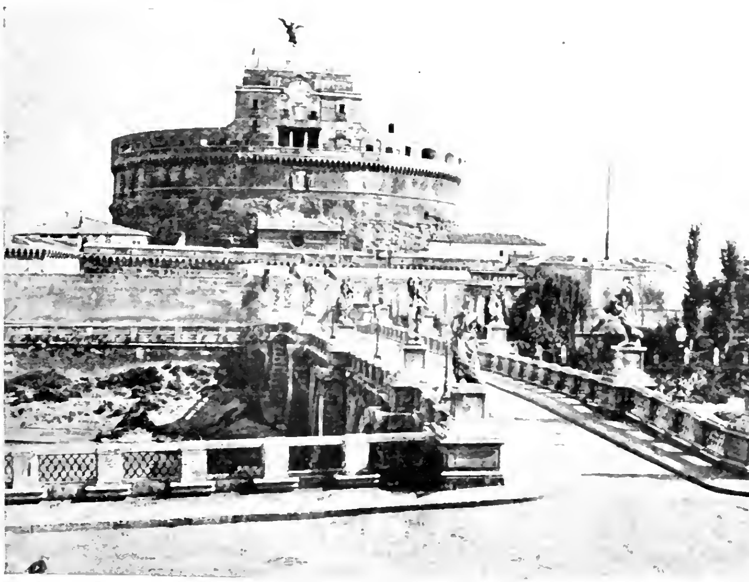
BRIDGE AT ALCANTARA, SPAIN.

from the instinctive and traditional gratitude that leads us to "speak well of the bridge that carries us safely across," from the sense of triumph over a stubborn obstacle, and from the religious sentiment that is associated with the grandest achievements of this kind both in ancient times and in the middle ages, there is a peculiar appropriateness in giving a memorial or monumental character to these structures, whether they carry railway trains or bicycles, and whether they cross rivers, streets, or rocky ravines. It is easily possible here to maintain the visible distinction between the utilitarian and the monumental, the lack of which distinction is so often fatal in the attempts to combine the two in one structure. Towers for military defence of the approach to a city or province, which gave such beauty and dignity to many of the bridges of the middle ages, are obviously useless at the present time, when an electric torpedo would hurl the most massive arches into piles of worthless rubble, when long-range cannons laugh at any river, however wide and deep, and when balloons laden with dynamite ride with fearful menace along the viewless highways of the air; but, if we cannot adorn our bridges with crenelated watch towers to repel invading foes, we can attach to them facilities for rest and recreation, and perhaps in some degree hasten the time when there will be no fear of hostile invasion.

In our abundance of land, few American cities would care to

THE OLD BRIDGE, TORCELLO, ITALY.

convert even the most central bridges that cross the rivers, providentially passing beside or through great cities, into mere extensions of the ordinary street, as was so often done in the compact, walled cities of medieval Europe. For more than three centuries the Ponte Vecchio in Florence has been bordered with jewellers' shops; the old London bridge, if the pictures tell the truth, might have been a double row of tenement-houses; and the description of the wooden bridge of Notre Dame, built in 1433, assures us that, while crossing it, one could not see the river, and, from the number and variety of the goods displayed in the shops, one would never doubt that he was on dry land. There is, in fact, ample precedent for any conceivable use for a bridge in



BRIDGE AND TOWER OF SAN ANGELO, ROME,

addition to its one essential function. Chapels were among the most common accessories, and the statues of saints and heroes along the parapets are quite in order. Shops for all kinds of merchandise,—

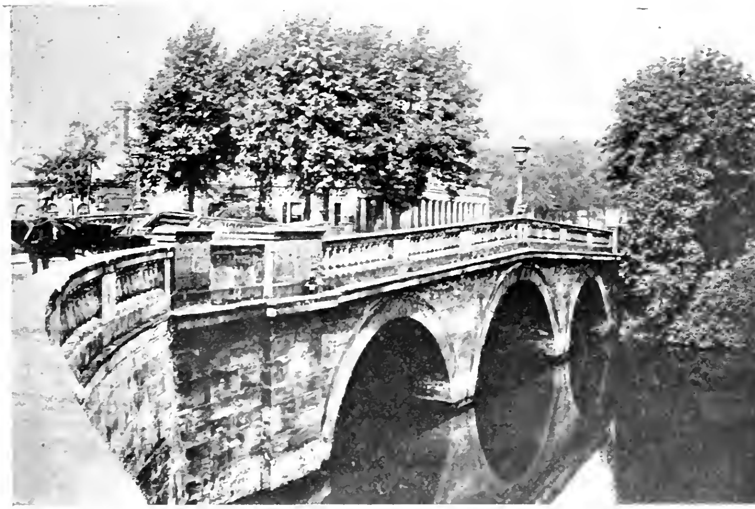
THE PONTE VECCHIO, FLORENCE, ITALY.

THE RIALTO, VENICE.

from fancy dry goods to live stock,—mills, factories, banks, schools, and prisons have rested upon the same piers that carried the bridges.

What would be far more suitable for our time and taste would be to make these urban bridges take the place of the public squares with

BRIDGE AT THE LAKES OF KILLARNEY, IRELAND.



THE BRIDGE, LEAMINGTON, ENGLAND.

which most of our cities are so scantily supplied. If our river-banks were always treated like the banks of the Arno and portions of the Seine and the Thames, there would be less need of using bridges for anything but travel. Unfortunately our river-banks are usually given over to commerce: or, worse, they are adorned with sewer outlets and factory tenements, and make a dumping-ground for garbage. But, by building the bridges that carry the streets across the river wider than the mere passing of travel requires, we have at once the most

THE "TWA BRIGS O' AYR."

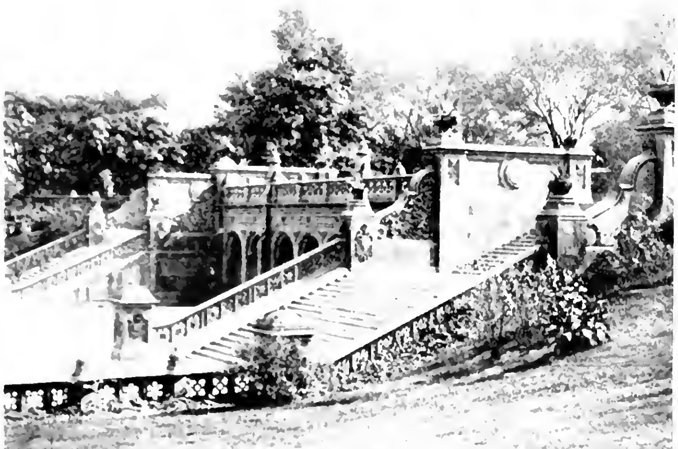
A WEST-SIDE ENTRANCE, CENTRAL PARK, NEW YORK.

IN GOLDEN GATE PARK, SAN FRANCISCO.

attractive public park and promenade possible. It is strange that the universal instinct to loiter on the bridge and watch the water beneath, with its celestial reflection from above and the landscape up and down the river, beautiful in its perspective however crude it may be in its near detail, has not led to a more frequent and comprehensive utilization of its possibilities for what may be called public-square purposes. Even where parks and squares are abundant, the open river is sure to be a favorite rival of green trees and verdant turf. But there is no reason why bridges of masonry, or even of steel, should not also have green turf and flowers and fountains at each side of the roadway,—more than that, pleasant resting-places and booths for refreshments. Why not, as well as in the parks and along the streets?

THE CUTSTONE ARCH.

DALEHEAD ARCH.



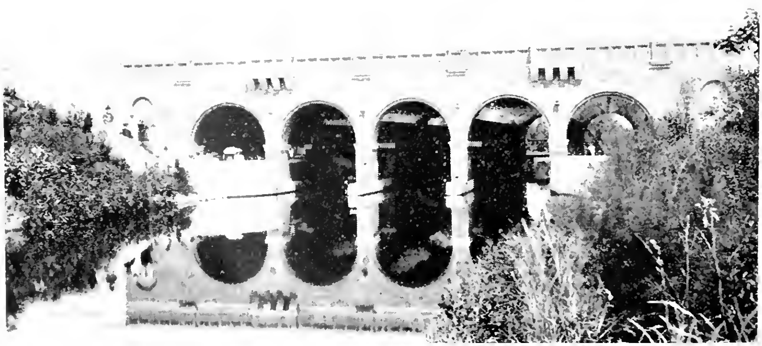
THE TERRACE.

THE MARBLE ARCH.

A GROUP OF BRIDGES, CENTRAL PARK, NEW YORK.

BOYLSTON ARCH, BACK BAY FENS.

AGASSIZ BRIDGE, THE FENS.



STONY BROOK BRIDGE.

BRIDGES IN THE BOSTON PARKS.

And why not even more than that? With floor and walls already provided, it only needs a permanent roof to convert a wide steel bridge into an enclosed gallery, like an arcaded street, in which the rents from the stalls along the sides would make the building of the entire structure a profitable financial investment. What virtually increases the practical economy of such additions to the superstructure is the fact that the main strength of the piers and abutments for a steel bridge is required to resist the force of the water, and the load imposed upon them is a matter of comparative indifference. Often, indeed, the heavier the load, the more secure is the bridge.

Concerning the masonry of bridges it is hardly necessary to suggest that heavy blocks of stone may be expected to resist the force of floating ice, logs, and other drift material that may be sent against them by the current better than anything smaller, but above this danger there is nothing more suitable for the structure than bricks. When it is remembered that, next to glass, burned clay is the most enduring of all mineral building materials, it is a singular conservatism that confines the use of bricks mainly to culverts, drains, and other underground construction. With the excellent building cements which are becoming more and more available,—apparently destined to rival those of antiquity, which are the wonder and admiration of modern times,—there is no limit to the availability of bricks in bridge-building, whether considered from the economical, the durable, or the esthetic point of view.

Where the span is too great, or other conditions make an arch or a series of arches impracticable, the first impulse would be to say that wooden trusses are at best wasteful,—a temporary economy resulting in ultimate loss. Still, we need not forget that from the time of Julius Cæsar until a comparatively recent date the most famous and serviceable bridges in the world were of wood. There were none but wooden bridges in Paris until within two or three hundred years, and there is no apparent reason why a well-planned wooden bridge should not enjoy a useful life as long at least as that traditionally allotted to the crow. This would call for the same protection from the action of the weather and the ground as would be given, as a matter of course, to any other wooden building resting on stone or brick foundations. Other things being equal, there is evidently more scope for architectural effect, both of composition and ornamentation, in a wooden structure than in one of iron. Here is another conspicuous inconsistency in the expenditure of public funds: it seems to be accepted as an axiom that, for the building of a bridge, nothing shall be allowed beyond actual necessities for the bare utilitarian needs; while a public building that may be seen less, used less, and be really of far less value to the community is often given a large percentage of its cost for purely esthetic ends.

The many beautiful bridges in our public parks, whether of wood, iron, or masonry, are admirable examples of what may be done by making these features of utility also objects of grace and beauty,—whether they are intended primarily to carry us safely over a chasm, or to create a pleasing detail in the landscape.

It may seem unreasonable to ask for a high degree of artistic excellence in the design of a bridge over a mill stream or a railway track, but the simple truth is that there will be no social or industrial salvation for us until we have learned to apply the best scientific knowledge and artistic training to everything we build, from barn doors and brick culverts to "marble domes and gilded spires." Our work must not only serve our necessities, but minister to our enjoyment; it must add something more than mere convenience to the value of life. And the more extensive it is, the more commonly used, and the more permanent its character, the more imperative is the obligation to give it the highest possible artistic quality.

ARE THE CYANID PATENTS INVALID?

By J. S. C. Wells.

THE use of potassium cyanid for extracting gold from ores and tailings is extending so rapidly that the validity of the MacArthur-Forrest patents covering the use of that solvent has become a question of much importance. Claims are already made that about one-third of all the current production of gold in South Africa is obtained by cyaniding, while, judging from recent progress in those gold fields and in the United States, it is quite possible that this method of extraction may soon be adopted in even larger proportion. Consequently the royalties now being paid and to be paid during the life of the original patents not only represent a large absolute sum, but are a serious tax upon the producer, if the process is adopted, or a restriction upon production where royalties would preclude profit to the owners of ore.

In order to obtain a valid patent. the patentee must be able to prove originality in his invention. Let us see if those in question fulfil this condition. To answer this intelligently, we must determine what was known as to the action of solutions of cyanids on gold prior to the dates of these patents.

One of the first investigators was Prince Pierre Bagration, who. when making certain experiments in 1844, used a gold-lined dish to hold a solution of potassium cyanid, and found that the solution dissolved the gold lining. This observation led him to further investigate the subject, and he found that gold precipitated from a solution of the chlorid by ferrous sulphate was also soluble in the cyanid.

In 1846 Elsner confirmed Bagration's observations, and proposed the equation which is now generally accepted as representing the action taking place when gold dissolves in cyanid,—*viz.*,

$$4\,Au + 8\,K\,Cy + O_2 + 2\,H_2O = 4\,K\,Au\,Cy_2 + 4\,K\,O\,H.$$

Numerous other authorities might be cited, all speaking of the solubility of gold in cyanid as a well-known fact. Gore, in his work on electro-metallurgy, makes the following statement: "If too much free cyanid is used in the gilding solution, the anode (gold) is dissolved whilst the current is not passing."

Faraday, in 1857, made practical use of the solvent power of cyanid for gold by using it to reduce the thickness of gold leaf which he was preparing for his researches on light (*Phil. Trans.*, 1857, p. 147). That air or oxygen was necessary to the reaction was also known to him, as is shown by the following quotation: "When one piece of gold leaf was placed on the surface of a solution of potassium cyanid, and another, moistened on both sides, was placed under the surface, both dissolved, but 12 minutes sufficed for the solution of the first, whilst above 12 hours were required for the submerged piece. In weaker solutions, and with silver also, the same results were obtained, from sixty to one hundred fold as much time being required for the disappearance of the submerged piece as for that which, floating, was in contact both with air and the solvent." He also tried gold precipitated in various ways, and found all soluble in cyanid.

W. Skey, in a paper on "The Electro-motive Order of Certain Metals in Potassium Cyanid" (*Jour. Chem. Soc.*, vol. 30, p. 588, 1876), makes a very important statement. Its bearing on the cyanid process is so direct that I quote it entire: "It must further be remembered that gold and silver are not quite insoluble in cyanid. The loss of metal which falls upon the mercury, gold, or silver of these blanketings (concentrates) depends, therefore, entirely upon the relative affinity of these metals for this salt. Now, it is distinctly affirmed that neither gold, silver, nor platinum directly precipitates mercury from its solution, but, on investigating this subject, the author found that in reality mercury is not positive, but very decidedly negative, to gold or silver in potassium cyanid,—gold and silver being dissolved in mercuric cyanid, while mercury precipitates. The following is a list worked out by the author, showing the electro-motive order in potassium cyanid of various metals occurring in gold fields or being employed for milling gold. It runs from negative downwards to positive: C, Pt, Fe, As, Sb, Hg, Pb, Au, Ag, Sn, Cu, Zn. All other ores occurring in nature are mostly negative to the whole series. Thus it is shown that, whenever potassium cyanid is used to assist in the amalgamation of blanketings, the loss falls upon the gold and silver present, the mercury being positively protected from the action of this salt by these more valuable metals."

The above quotation covers all the principles of the cyanid process. We have the solution of the gold and silver in the weak cyanid, and, as shown by the list, the fact that they are precipitated from such solutions by zinc. It is evident, then, that the solvent power of cyanid for gold and silver was known long before the MacArthur-Forrest patents were granted; consequently they have no claim to novelty or invention in that respect. Their use of it as a solvent for the gold in an ore does not alter the case in the least; the gold is there present in the metallic form, and the reaction is precisely the same. Even limiting its use in this way, they have no new discovery, for Skey, as shown in the previous quotation, speaks of the solvent action of cyanid on the gold contained in an ore, and Dr. Henry Wurtz, in a paper on "Magnetic Amalgams" (*American Journal of Science*, Vol. XLI, 1886), makes the following statement: "When gold has been obtained in solution, *either from ores* or from other materials, by the action of chlorine, aqua regia, *potassium cyanid*, or any other solvent; also, when silver has been obtained in solution in hyposulphite or otherwise," etc., then the precipitation of the metals from such solutions is more rapid and thorough, if the solutions are dilute."

It is evident from this that he was familiar with the fact that potassium cyanid would dissolve gold from its ores, and also that it was advantageous to use dilute solutions.

Cyanid was used in 1867 by Rae for dissolving gold from its ores. True, it was in conjunction with an electric current, but, as every chemist knows, the reaction would be practically the same. The electric current, if it took any part whatever in the solution of the gold, simply decomposed the potassium cyanid into cyanogen and potassium, the latter decomposing water and forming potassium hydrate. The cyanogen set free would then be ready to combine with any gold that was within reach and form aurous cyanid, this combining with more potassium cyanid to form potassium aurous cyanid. The reaction would then be:

$$Au + K\,Cy + Cy = K\,Au\,Cy_2$$

practically the same as when potassium cyanid alone was used, cyanogen being the solvent in both cases.

Rae's patent clearly covers the claim made in the MacArthur-Forrest patent for "a cyanogen-yielding substance," potassium cyanid, when acted on by the electric current, certainly yielding cyanogen. By his process, however, a large part of the gold must be dissolved according to Elsner's equation, without the aid of electricity. His method covers, therefore, the use of "a cyanogen-yielding substance," and of potassium cyanid alone; so it is hard to see what is left for Messrs. MacArthur and Forrest to base a patent on.

Simpson also antedated them in the use of cyanid on ore, his addition of a little ammonium carbonate and common salt having no effect on the results obtained other than the action of the carbonate as a neutralizing agent in the case of an acid ore.

So, in fact, we see that the idea is not new in any sense. That it was well known long before 1887 that cyanid would dissolve gold is clearly proved, and that it would also dissolve gold when contained in an ore was not new, as it had already been used for that purpose. It seems hardly possible, then, that any claim to novelty in the use of cyanid as a solvent would be upheld in any court.

In their American patent they try to avoid this difficulty by claiming only the use of solutions containing 2 per cent. or less of potassium cyanid, and further claiming for these dilute solutions a so-called selective action, meaning by this that such a solution will dissolve the gold in preference to the base metals. They say that, if a strong solution is used, the base metals will be dissolved in place of the gold. This, as shown by Skey's researches, is not true, with the exception of copper and zinc. That these two metals will dissolve before gold, even in very dilute solutions, is well known to any one familiar with cyaniding. The presence of copper minerals in any quantity is fatal to the success of the process, owing to the selective action of the cyanid on the copper in preference to the gold. An example of this may perhaps be interesting. A lot of tailings containing some copper (as sulphid) was sent to me to be tested with cyanid. They were mixed with lime at the rate of 10 lbs. per ton,—more than sufficient to neutralize the ore,—and then treated with a 0.5 per cent. solution of potassium cyanid, at the rate of 1½ tons of solution to 1 of ore, for 58 hours. The result was an extraction of 50 per cent. of the gold and 35.5 per cent. of silver, and a loss of 10.6 lbs. (64 per cent.) of cyanid per ton of tailings.

Another test was made, using a solution containing only 0.25 per cent. of cyanid (1 ton of solution to 1 ton of ore), and reducing the time to 25 hours. In this case the extraction of gold was 20 per cent. and that of silver was 20 per cent., and the loss of cyanid was 4 lbs. (80 per cent.) per ton.

The original tailings contained 0.5 oz. of gold per ton; to convert this into potassium aurous cyanid would require 0.33 oz. of potassium cyanid. Hence, in the first test one thousand times the quantity of cyanid used in combining with the gold was lost by its combinations with other substances. In the second the proportion was nearly the same, the loss of cyanid being nine hundred and seventy times as much as that entering into combination with the gold. Truly, this is selective action with a vengeance, but hardly in favor of the gold.

Ores containing decomposing iron pyrites cannot be treated directly by cyanid, no matter how dilute the solution may be, as the cyanid would at once combine with the iron salts present. In some cases previous treatment with alkali will overcome the difficulty. Iron or copper pyrites are of such frequent occurrence in gold ores that ores containing one or both will form a large proportion of the material offered for treatment. If they have been at all weathered, they will contain decomposition products that must be removed or neutralized before successful treatment is possible. As for lead compounds which sometimes occur, it was well known years ago that the sulphid, sulphate, and carbonate were all insoluble in potassium cyanid. So also with zinc sulphid and carbonate of lime, and other metallic combinations.

It is plain, therefore, that the claim of the patentees narrows itself down to this: if you treat an ore that contains nothing soluble in cyanid except gold and silver, or one from which all other soluble substances have been removed, then the cyanid will dissolve the gold in preference to the remaining well-known insoluble compounds. A wonderful discovery, surely, on which to base a patent!

What seems to me another vital defect in the American patent is the claim there made for cyanid as the solvent "without the use of any other active chemical agent." Cyanid under such conditions is not a solvent for gold, as has been shown by many experiments. Faraday, as already stated, was aware of this fact; Elsner also knew it, and states that oxygen is necessary; and McLaurin, in his very exhaustive research, has proved beyond question that, unless oxygen is present, the gold will not dissolve. He has further shown that the reason a weak solution of cyanid is a better solvent for gold than a strong one is found in the fact that the former contains more dissolved oxygen than the latter. It is also proved by his experiments that the solvent power of cyanid for gold increases as the strength of the solution increases, until the point is reached at which it contains its maximum quantity of oxygen, and from this it decreases as the amount of dissolved oxygen diminishes. The reason, then, why a dilute solution (*i. e.*, down to 0.25 per cent.) is a better solvent than a strong one is found in the fact that the point of maximum solubility of oxygen occurs in a solution containing 0.25 per cent. of potassium cyanid. If we could introduce a greater proportion of oxygen into a strong solution, it would no doubt be a better solvent than the weak one. My own experiments also prove the necessity of oxygen, and further show that, the more oxygen present, the more rapid is the action. In the following table are given the results obtained in a series of four tests. The pieces of gold used were all taken from a large gold cornet. The strength of the different solutions was as follows: potassium cyanid, 1 per cent.; potassium ferricyanid, 5 per cent.; sodium dioxid, 2 per cent.; hydrogen dioxid, 2 per cent. The solution used in test No. 1 was boiled for half an hour to expel air, the piece of gold then added, and the flask tightly corked.

It will be seen from the table that, when the air was expelled, the solution of the gold was practically *nil*, but, as the amount of oxygen increased, so did the solubility of the gold.

*SOLVENT.	Weight of gold before treatment.	Weight of gold after treatment.	Per cent. dissolved.	Time.
1. 100^cc boiled K Cy	0.1249 grms.	0.1245	0.3	3 hrs.
2. 10^cc K Cy	0.0654 "	0.0606	7.3	"
3. 10^cc K Cy, 2^cc Na_2O_2	0.0885 "	0.0636	28.1	"
4. 10^cc K Cy, 2^cc H_2O_2	0.1074 "	0.0783	27.1	"

MacArthur, in a paper read before the Society of Chemical Industry, claims that oxygen is not necessary for the reaction, at least not for ores, stating that he had made experiments on them and found no difference in the results, whether air was present or not. What method he used to prevent access of air he does not say.

To test the truth of this statement, I took a quantity of tailings, mixed them very thoroughly, took out a sample for assay, and divided the remainder into three equal portions, which were then placed in glass cylinders provided with filters, and treated as follows:

No. 1. The cylinder containing this sample was fitted with perforated rubber corks at both top and bottom, one hole in the lower one, and two in the upper, and short pieces of glass tubing were passed through the openings. Two flasks were then filled, one with a 1 per cent. solution of potassium cyanid, and the other with distilled water. Both flasks had doubly perforated corks, through which glass tubes were passed, one tube in each, reaching to the bottom. The solutions were then boiled for half an hour, and at the expiration of that time the loss by evaporation was made good by the addition of sufficient boiling solution of the same kind to completely fill the flasks, and cause them to overflow through the outlet tubes. The latter tubes were then clamped, and the flasks inverted and placed at a higher level than the cylinder. The one containing the boiling water was then connected with the bottom of the ore cylinder, and the hot water allowed to rise slowly through the contents until it overflowed through the tubes at the top, thus driving the air before it and out of the cylinder. The tubes, while still full of hot water, were closed by short pieces of rubber tubing and clamps. The flow of water being shut off, the flask was disconnected from the bottom of the cylinder and connected with one of the upper tubes. The flask of cyanid was next connected with the other upper tube, and the solution allowed to run through until it had displaced the water, and the filtrate showed

* These experiments would indicate that an aëration of the cyanid solution, either by allowing it to fall into the sump in the form of a spray or shower, or by forcing air through it, might perhaps be advantageous, when working on a large scale.

a strength of 0.5 per cent. of cyanid. The flow of solution was then stopped, all the tubes closed, and the test allowed to stand for 24 hours. At the expiration of this time water from the flask was allowed to flow in and displace the cyanid, and the washing continued until the wash water showed only a trace of cyanid. The filtrate from this test was reserved for use in No. 3. The leached residue was dried and assayed, and found to contain $7.23 in gold per ton,—an extraction of 23.8 per cent. The original tailings assayed $9.51 in gold. The result in this case would doubtless have been even more conclusive, if it had been possible to totally exclude the air.

No. 2. For this test the cyanid remaining in the flask from test No. 1 was thoroughly shaken so as to aërate it, and then added to the tailings in sufficient quantity to cover them, and allowed to digest for 24 hours. At the end of this time it was run off, and the residue washed with water, until it showed but a trace of cyanid. On assaying the residue, it was found to contain $3.31 in gold per ton,—an extraction of 65.18 per cent.

No. 3. In this case the filtrate from No. 1, largely diluted with the wash water as it was, was well shaken to aërate it, and then the third sample of tailings leached with it, in exactly the same manner as in No. 2. The residue, on being assayed, gave $4.55 in gold per ton, equal to 52.1 per cent. extraction,—a fairly good result, considering the weakness of the solution and the comparatively short time it was in contact with the ore.

No one, I am sure, not even Mr. MacArthur, will deny that oxygen is a chemically active agent, and we see from all the experiments given that it is absolutely essential to the success of the process,—not in infinitesimal quantity either, for, calculating from the equation given, we find it to be equal to 6.14 per cent. of the cyanid.

To sum up, we see, first, that there is no novelty in the use of cyanid as a solvent for gold; secondly, that the claim for selective action is not true; and, lastly, that cyanid without any other chemically active agent is not a solvent for gold. The patentees, therefore, have no claim that will stand examination, and surely no valid patent can stand on such a foundation.

That zinc would precipitate gold from its solutions was known many years before Messrs. MacArthur and Forrest took out any patent for its use in that way. It was so used to regain the gold from old plating solutions, by first acidifying them with hydrochloric acid, and then boiling. This precipitated a certain amount of the gold, leaving a considerable quantity still in solution as cyanid. Zinc filings were next added to the solution, completely precipitating the remaining gold (*Chem. News*, Vol. 8, p. 31).

An objection may be made to this on the ground that the solution here spoken of is an acid one, and therefore not comparable with the precipitation from a solution of potassium cyanid. At first glance this might seem true, but we must remember that hydrochloric acid does not decompose aurous cyanid, so the reaction in this case would be between aurous cyanid and zinc, thus:

$$2\ Au\ Cy + Zn = 2\ Au + Zn\ Cy_2.$$

The zinc cyanid would be at once destroyed by the acid present, forming zinc chlorid and hydrocyanic acid.

The above reaction is similar to that taking place in the zinc boxes, for there the gold is precipitated from the solution according to the following:

$$2\ K\ Au\ Cy_2 + Zn = 2\ Au + Zn\ Cy_2 + 2\ K\ Cy.$$

It will be seen from this equation that the potassium cyanid undergoes no change, its combination with the aurous cyanid simply being broken up, and the gold of the latter then precipitated, as shown in the first equation.

That zinc was a precipitant of gold from solutions of potassium cyanid was also known. Skey found it to be electro-positive to gold in such solutions, and consequently a precipitant for it. Price, in England, has also taken out a patent for zinc as a precipitating agent for gold (No. 5125–1884). The mere fact of using zinc in a filiform condition should certainly not be sufficient to make the patent valid. The object in using it in this state is to expose as much surface as possible to the action of the solution. The same result is accomplished by the use of zinc filings, which had previously been used for this purpose.

It would seem, then, that both in the patent for the use of cyanid as a solvent for gold, and in the one covering the use of zinc to precipitate it, the patentees are claiming as their own, discoveries that were public property long prior to their patents.

THE NATURAL WEALTH AND INDUSTRIAL POSSIBILITIES OF CUBA.

By Raimundo Cabrera.

SHOULD Cuba in the near future succeed in solving the formidable political and economical problem which she is now facing, and be successful, as well, in establishing in absolute peace a system of home rule which will permit her to develop without hindrance her inexhaustible natural resources; should she inspire confidence in capitalists and encourage the noble ambitions of the workingman,—she would certainly, in a short time, be as prosperous as California or Australia is to-day, and would, like them, attract the admiration of the world because of her wonderful development.

Cuba has in her fertile soil all the natural conditions required to attract immigration, to awaken the spirit of enterprise, and to reimburse with great profits the money which may be invested in agricultural, industrial, and mining enterprises.

Suffice it to say that four-fifths of her extensive and fertile territory, whose area is a little less than that of the State of New York, is as yet in a virgin state; the axe of the woodman has not disturbed its primeval forests, nor the drill of the miner perforated its mountains. The cultivated area after four hundred years of Spanish colonization is only about 1,046,115 hectares, while there are 12,827,206 hectares yet uncultivated and 9,248,660 hectares of virgin mountains.

Experience has shown that the fertility of these lands is simply incalculable. Should Cuba, which, owing to different and heretofore insurmountable causes, has a population of only 1,631,687,—in the proportion of 133 to each square kilometer,—freely open her many sea-ports and invite Anglo-American and European immigrants, the lands at present unproductive, one-eighth of which lie idle in the hands of the government, would yield abundant food and offer a prosperous future to a population of 9,000,000 in the 118,043 square kilometers which the island contains.

It is not only the grinding of sugar and the cultivation of the cane and tobacco that would give employment to the masses of immigrants. Just as the United States are able to supply all the wants of their great population because of the diversity and abundance of their agricultural and manufactured products, so could Cuba supply her population, if her natural resources were worked out, and at the same time export to other countries.

All the leguminous plants and cereals grown in North America, and the seeds of which have been imported into Cuba, grow there even more luxuriantly. The cultivation of farms supplies the great centers of population, but is confined at present to small strips of land contiguous to the cities of Havana, Matanzas, etc., the farmers never having pretended, as yet, to supply the demand of more distant markets. The rice grown in the southern States or in India is not more nourishing than that produced in Cuba, and yet the island does not supply even the local consumption. The Cuban corn is unsurpassed in its farinaceous principles, and yet it is raised there only to a small extent. Wheat has been grown on an experimental scale with complete success; nevertheless, it is not cultivated, and the country is compelled to pay high duties on foreign flour. Besides, there are numerous indigenous plants which are very rich in nutriment and quite suitable for food, such as the tamarind, peas, beans, lentils, etc.

The great variety of the Cuban fruits is the wonder of the foreigner who visits the island, and has taken up many pages in the botanical catalogues. This important branch of agriculture is entirely neglected there. The New York *gourmet* who delights himself contemplating the beautiful peas, apricots, plums, and raspberries which are brought daily to the markets and which the western trains bring within reach of his hand has no idea whatever of the immense quantity of delicious fruits which grow almost wild in the Cuban plains, to say nothing of the banana, of which there are many varieties and sizes, and to the cultivation of which the Baracoa district is devoted, or of the cocoanuts or pine-apples, for which there is a great demand in the United States, or of oranges, which are superior, by reason of the perfume of their peel and the sweetness of their acidulated juice, to those from Florida; in fact, there exist there so many kinds of delicious fruits that, were their cultivation and improvement entrusted to the hands of skilful planters, they would become an important source of wealth. Such are, for instance, the limes, sweet grape fruit, citron, sweet sapote, the white and purple caimito, two kinds of mammee sapotas, anon, mangoes, chirimoya, guanabana, pomarosa, canistel plums, watermelon, and many others, the enumeration of which would occupy too much space, but none of which fail of importance if we take into consideration the sweetness of their pulps, their nourishing and healthful juices, and the uses to which they may be applied. The cultivation of strawberries, peaches, pears, and apples has been successfully tried there, and it has been affirmed that the soil of Cuba, which produces a kind of wild grape, is as fit for the cultivation of the vine as that of California, which now shares this industry with Europe.

Figs are grown in the gardens in great profusion, but are cultivated only for pastime.

The exploitation of medicinal and aromatic plants, of which there is a great variety, is as yet in an embryo state in Cuba. They are neither exported or employed in commerce to any extent, or utilized at home as domestic remedies. In this class belong the red Indian dwarf pepper, the sweet basil, mint and peppermint, wild and sweet marjoram, thyme, balm-gentle, chamomile, royal itamo, salvadera, and the higuereta, from which castor oil is extracted. In the marshy lands, near the coast, shrubs called mangles, from which tannic acid or tannin is obtained, grow in great profusion. In the woods are to be found copal and resin, rich sources of essential oils or spirit of turpentine, to say nothing of the immense amount of resin which the innumerable pine forests of the province of Pinar del Rio would yield.

There are many indigenous textile plants; cotton grows wild in the fields and forests, of a quality equal to that grown in Virginia, but not a single bale has ever been packed; the cultivation of ramie, hemp, and the Indian fig are awaiting development in great stretches of land at present uncultivated. It has been practically demonstrated that there are lands in Cuba most admirably adapted to such cultivation; if attempts in this direction heretofore have failed, it is owing to the exorbitant duties imposed upon imported machinery, besides many other exactions and impositions which are simply ruinous in their effect.

There are undeveloped fields in Cuba, even where the appearances are more unpromising and insignificant. In New York, in Philadelphia, in Chicago, in all cities of any importance here as well as in Europe, floriculture is a profitable occupation; yet the cultivation of gardens is completely neglected in Cuba. On the banks of its rivers, brooks, and ponds, on its virgin mountains, flowers are seen perpetually blooming in most brilliant variety, filling the fields with their exquisite perfumes and entirely neglected by the botanist.

But there is no richer field for enterprise than the one offered by the precious forest woods, which afford an excellent material for building purposes. It is impossible to enumerate them all. Cedar, mahogany, ebony, the royal palm, oak, pine, are names familiar in North American markets. The same is not true of quiebrahacha, acana, hocuma, jiquí, yaya, dagame, macagua, and a hundred more which are as yet almost unknown, but eminently fit, on account of their hardness and dimensions, for naval constructions. And for cabinet work there is a great variety of fancy woods, with beautiful veins and exquisite shades, famous for their strength and elasticity; as the sabina, sabicú, caracolillo, granadillo, guayabo, etc.

There are so many agricultural possibilities as yet undeveloped in the most fertile lands of the island, so aptly termed the Pearl of the Antilles, that many pages might be written simply in their enumeration and description. At present, the condition of Cuba may be compared to that of the western territories when they were controlled by the Indians; that is to say, it awaits the influx of an intelligent and industrious population to bring activity, money, machinery, railroads, modern appliances, agricultural implements, in short, everything which would tend to draw from the fertile soil the wealth that lies hidden there. But, if so many opportunities for the development of new industries are lost for lack of population and cultivation, what might not also be said of the medicinal mineral waters which flow in great abundance in the mountainous regions and, were they known and their healthful properties appreciated, would certainly be in as great demand as Apollinaris? The renowned watering-places of San Diego, Madruga, Santa Fe, and San Miguel, recommended by wise European hygienists, but at present entirely neglected, would be sufficient in themselves to yield great profits to those who develop them.

The coasts of Cuba, especially in Vuelta Abajo and the central provinces, are rich in salt mines, whose deposits are wasted, inasmuch as this industry has never been developed and the article used in home consumption is imported from Spain or other countries.

The Cuban fish is not a whit less nourishing or palatable than that to be found in the waters of Gascogne or Nova Scotia. There is no doubt that the canned-fish trade and the exportation of the product would yield great profits. The eminent Cuban naturalist, Poey, exhibited at the Amsterdam Exposition a description of seven hundred and fifty-eight species, from the salmon and codfish down to the delicious sardines so highly prized by all good livers, to say nothing of the species peculiar to those waters, like the pargo, cherna, guaguancho, etc. The Cuban oyster, more highly flavored than the American article, richer in nutritious elements, is propagated to an infinite extent in natural beds, in spite of the fact that these have not been subjected to modern improvements.

Cuba has been explored, but not developed. Not even those incalculable quantities of guano stored away in its numberless mountain caves—such as Cotilla, Candela, Cubitas, and the labyrinths of Escambray in the eastern department—have ever been gathered, notwithstanding the fact that it is an excellent manure, fit for exportation, and would command high prices in foreign countries. What wonder that such is the case, when we there find all mining industries neglected, and the rich subsoil as yet untouched by the hand of man!

Cuban mineralogy has been the object of deep study on the part of foreign and native *savants*. Among other authors who have devoted their enthusiastic attention to it we may mention Le Sagra and Baron Von Humboldt.

There are gold mines in Holguín, Cienfuegos, Trinidad, Santa Clara, and San Juan de los Remedios; copper and silver mines in Santiago de Cuba and Puerto Principe; iron mines in Sierra Morena; magnetite mines in Juragua, Bayamo, Nuevitas, and Cubitas; asbestos, sulphur, mica, mercury, and coal in several other sections of the island; serpentine in Guanabacoa and Trinidad; quartz and feldspar in Escambray and Pinar del Rio; agate, carnelian, antimony, granite, chalk, asphalt, baryta, and petroleum in several other sections, and an abundance of white and colored marble. In short, there are mines, but not miners, in Cuba. There is a total absence of mining enterprise.

English and American capitalists undertook, some years ago, to extract from the mines of the east, on a small scale, the iron, copper minerals, manganese, and asphalt which they contain, and they have been exported in the following proportion:

Iron	400,000	tons.
Manganese	800	"
Asphalt	1,000	"
Copper	200	"

When the onerous custom duties which actually bar out the powerful machinery manufactured in the United States shall be removed, and the mining industry freely and vigorously prosecuted in Cuba, then the credit which that privileged island enjoys abroad because of its wonderful natural resources will be greatly strengthened.

Cubans, owing to causes which we will not here mention, have committed the grievous error of devoting their whole energies to the sugar and tobacco industries. A naturally industrious, bright, and persevering people, struggling against the numerous legislative hindrances which actually handicapped their individual faculties, the Cubans sought a fanciful compensation to their efforts in the bright prospect which the sugar and tobacco industries seemed to offer them.

They gave up the raising of cocoa, which yielded a very profitable return, and was exported to a considerable extent; they also neglected coffee, which competed favorably, in flavor and quality, with Mocha, and was at one time one of the most favored staple products of the island; they likewise abandoned the minor agricultural industries, until they so far failed to yield the necessary supply for home consumption as to compel workingmen to depend upon canned goods imported from the United States; they entirely lost sight of the fact that the potato crop of a single section—the municipality of Güines—amounted to two million dollars in one year; they entrusted the cattle industry entirely to the farmers of Sancti-Spíritu and Puerto Principe, where, up to the year 1894, over 3,000,000 head of cattle had been gathered,—a sufficient number for home consumption; and they devoted their energies almost exclusively to the sugar and tobacco crops.

Their aim was to become the greatest sugar-producing people in the world, and at one time they succeeded in their purpose. But they overlooked the fact that foreign competition and the lack of official protection, together with the overwhelming taxes at home, would surely ruin their business, cripple their country, and disturb the equilibrium of trade, through the lack of other compensating industries.

Whatever may have been the consequences, it behooves us only to point out that the tobacco grown in Cuba is the best known in the world; that the Vuelta Abajo leaf is universally famous; and that all competition by the tobacco-growers of Kentucky, Virginia, and the French and English colonies has been of no avail, the superior quality of the Cuban leaf being due to the climate and the soil.

Cuban tobacco has been exported to the United States as follows:

YEARS.	LEAF TOBACCO.	CIGARS.
1889........	5,600,000 pounds.	3,500,000
1890........	7,100,000 "	3,900,000
1891........	7,100,000 "	3,300,000
1892........	7,900,000 "	2,800,000
1893........	8,900,000 "	2,700,000

According to late statistics, the United States has recently imported yearly from Cuba 13,950,000 pounds of leaf tobacco and 983,893 pounds of cigars.

The remarkably fertile soil of Cuba seems to have been especially endowed by nature for the cultivation of the sugar cane. There are sections, like eastern Cuba, where canes attain a growth of thirty feet in height and five inches in diameter. They contain a prodigious amount of saccharine matter.

The number of plantations which were working in Cuba during the season 1893-94 was 409, and the sugar production reached in that year 1,017,612 tons. During the ten previous years the average was 612,000 tons a year. When the production of sugar was not so extensive as it is at present, and competition was much less, Cuban sugar reached a price as high as $90, $100, and $134 per ton. The excess of production has lowered the price. To-day it commands less than $60 a ton, and the business is weighed down by great hindrances in the form of export duties, duties on machinery, internal taxes, and by the total absence of official encouragement and protection.

In short, if, in order to duly appreciate the opportunities and inducements offered to American capitalists and tc open the way to immigration, a careful study is made of the topography, geographical situation, means of transportation, and other features which may tend to improve the endless natural resources of that land, one is irresistibly drawn to the conclusion that it is destined to become the Mecca of all future American enterprises.

The island, as is well known, lies at the entrance of the Gulf of Mexico, and has a length of 816 miles on the north and 903 on the south, and an area of 34,716 square miles. Its smallest width is 22½ miles, and its greatest width 135 leagues. Its long sea-coast is indented with all kinds of ports, harbors, bays, creeks, etc., as yet unopened to commerce and navigation, but which must surely invite the genius and enterprise of a thrifty and ambitious people, since they could, in combination with suitable railroads and adequate means of river navigation, afford an outlet for the immense and as yet undeveloped products of that marvelous land.

The climate is delicious. In summer the temperature ranges from 70° to 84° F., and the heat is tempered by a perpetual sea-breeze. In winter the mercury never goes lower than 50°.

There can be nothing more undeserved than the unsavory reputation which the climate of Cuba has acquired. Yellow fever is prevalent in some places, like Havana, not on account of the climate, which is absolutely healthful, but through the lack of an efficient board of health, and the filthiness of the ports, entirely neglected by the government. Just as in Florida the plague has been banished by wise regulations, so the same results will surely be attained in Cuba after the reorganization of the country.

The roads are few and primitive; communication is difficult, and at many points of the country travel is impossible. There are only three roads in the province of Havana, and these but thirty-six miles in length,—one leading to Güines, another one to Guanajay, and a third to Marianao.

As to railroads, there are only 1,500 kilometers in operation, although the country is in sore need of them, as the small local affairs rendering service for the plantations are scarcely worth mention.

The Vuelta Abajo district, where the renowned Cuban tobacco is produced, will become an emporium of wealth when new roads and other means of communication carry the products of that privileged region promptly and easily to the neighboring ports of the north and south coasts, which at present are entirely neglected.

The province of Santa Clara is more sorely affected in this respect than any other. There is urgent need of a railroad connecting this province with that of Puerto Principe, the great cattle-raising province (where a complete system of railroads has become an actual necessity), and with the eastern department, where the mining industry and the fruit trade with the United States have their seat.

All these splendid opportunities are loudly calling for the investment of American capital, to say nothing of the cities and towns where electric, cable, and other railroads would be gladly welcomed by the people. Havana is the only place where street railways are to be found, and there only in a very primitive state, wholly dependent upon animal power. There is also a vast field for investments in gas and electric light companies, as well as in water works and other modern improvements.

Finally, the machinery which is now imported from Belgium, England, and France, and which can be more advantageously provided from the United States, constitutes another powerful inducement for American enterprise. In fact, the whole island is open to the wide-awake genius of this country.

How could all this be accomplished?

By modifying the present commercial relations between both countries; by establishing an equitable and close intercourse between them; so that by reciprocity treaties, or through other more efficient, solid. and sympathetic means, free trade should be firmly established between Cuba and this republic.

What should this means consist of? Only the future can answer this question. Cuba on the south claims her rights and opportunities, as California and the remote regions of the west claimed theirs. Four-fifths of that fertile country is as yet unbroken land, where three yearly crops are obtained, where there are innumerable mining resources, where virgin forests abound, and where there are, in a word, countless opportunities for labor and capital.

Cuba is nearer and more accessible than the Pacific States. Her ports are only fifteen hours from the most southern ports of the United States. It is now possible to travel from New York to Cuba in seventy hours, and facilities will increase with the establishment of better steamship lines. It would be possible to manage a railroad system, or any other concern having its field of operation in Cuba, from New York, Philadelphia, or Boston, with less difficulties than those encountered by the managers of the Oregon or Arizona enterprises.

On the other hand, Cubans are well aware that their destiny is closely allied to and dependent upon their most intimate relations with the markets of the American union. Let us confidently await the time when, through mutual agreement, Cuba shall become a veritable emporium of agricultural and industrial wealth, and cease to be merely a wonderful, but unproductive, field of natural resources.

MODERN MACHINE-SHOP ECONOMICS.

By Horace L. Arnold.

V.—THE NEWER TYPES OF METAL-CUTTING MACHINES.

THE machine-shop superintendent desires to produce the most work for the least cost. The work consists wholly in changing metal forms, by founding, by forging, and by cutting; these changes in metal form are produced partly by natural, unintelligent agencies, and partly by the efforts of the workmen. Fire and water; the stream of melted metal flowing into the mould; the hammer and anvil; the hammer and chisel; the muscles of the moulder, the blacksmith, and the whitesmith,—these were the agencies by which Tubal Cain and the builders of Solomon's Temple wrought their marvels, and they are the agencies which the machine constructor must employ to-day. There has been no broad change in the means of working metals and changing metal forms from the very first until now, excepting electro-plating, and that marvel does not greatly affect machine construction, because of its comparatively great cost and the uncertainty of its results in large masses.

The hammer and chisel, the file and the lathe, and the workman are still the agencies with which the machine-shop superintendent must do his work, and the single problem of the superintendent's shop-life is to find the most effective use of these simple agencies, to learn how to make the greatest change in metal forms with the least cost, and so build the most machinery for the least money.

Labor is the costly factor in machine production; the shop and tools, once furnished, stay there; they last long and cost little for maintenance or renewal; labor is a constant and great expense; the most work for the least labor is immediately seen to be the real problem, and its only solution lies in making machines build machines, instead of using men for that purpose. In case of a simple form of small machine, like a pin or a cartridge-shell or a screw, manual labor can be almost wholly replaced by machine work. A screw-making machine may work for an entire day, or sometimes for several days together, without being touched by the hand of man. Even in the case of pieces weighing hundreds of pounds, suitably-contrived machines can reduce the labor cost of finishing to inconsiderable sums, so that the very same operation might have a labor cost in one good machine shop of, say, a dollar, while in another shop the labor cost would be only ten cents, the difference in the two shops being that the one is fitted for general work only, while the other is supplied with special agents for producing this particular form of piece. The superintendent is, therefore, confronted at the outset by the problem of tools specially suited to his work. He sees a tool, fitted for a certain operation, reduce the cost of that operation to a small fraction of its cost by ordinary methods of finishing, and draws the general, and true, conclusion that equally suitable tools for his entire range of operations might vastly reduce the total cost of his work. Following this conclusion, he also sees that no shop can be large enough, and no shop-owners can be rich enough, to equip a shop in the best manner for making all kinds of machines, and this leads at once to the special shop, fitted with specialized tools for the production of one particular machine. He sees also that the general shop can draw revenue from many near-by sources; his own shop may have an established and valuable trade in many different lines; if all but one of these lines of production are abandoned, then he must go far afield to market his wares, which means a vast selling expense connected with his cheap product, and the concern's eggs all in one basket; rivals may enter the field, close competition may follow his successful efforts, and ruin supplement his most triumphant success in production of the single thing.

The old shops began with the hand-lathe about a hundred years ago, as the sole machine tool. All that could not be done on the hand-lathe was done in the smith shop, or with the hammer and chisel and file. Everything else has come into the machine shop within the last hundred years, and almost all of it within the memory of men still in service: and all that we now call modern or regard as effective is of very late construction indeed. Fifty years ago the iron planer was a special tool, and there was not an efficient engine lathe in the world perhaps,—certainly not in America; drilling machines, milling machines, and chucking machines were generally not known at all, and where some raw, inefficient form of either of these machines was known, it was regarded as a doubtful experiment, and the milling machine, in which the multiple-cutter idea is carried to the ultimate, is still an uncertain factor in machine production.

The well-informed, broadly-seeing superintendent passes this review of the old days before his eyes, and sees that the end has not been reached; that he may yet vastly reduce the labor cost of his product by improving his metal-cutting machines; and that more roads to prosperity will be open to him if his improved tools are general in their field of usefulness than if they are narrowly limited in lines of efficiency. He can draw but two conclusions: he must either select one specialty, and sink or swim as he fails or succeeds in his effort to lead his rivals; or he must use the best general tools which he can buy or make, and must reduce the labor cost attending these superlatively excellent general tools to the lowest possible figure, and so be prepared to meet general demands for machinery with the most efficient and economical means for general machine production. If he has an old and inefficient plant, he must throw it away, either piece-meal, or in a lump. If he has workmen whose motto is "a fair day's work for a fair day's pay," he must either have a new force, or he must change the views of his old hands. And he must work his changes slowly, gradually, imperceptibly almost, or he will lose the confidence of his employers and antagonize his men, and end in the disreputable loss of his position. It is the superintendent who must order the shop equipment, and must direct changes and be responsible for economic production ; hence the superintendent is here treated as the principal. The owner and manager desires cheap production, but he does not desire to make a large outlay to secure this low cost of work ; his tools were the best at the time of purchase, and the manager is loth to believe that these one-time masterpieces are not still the best of their kind, or so nearly equal to the best as to make any wholesale replacing of his plant not only needless, but absurd. Yet the competent and well-informed superintendent knows perfectly well that he could double, treble, or quadruple the result of an hour's work by the use of tools that are not experiments, but thoroughly tried successes. Some of his tools are too light to take the heavy cuts which work would stand : other machines which might well have several tools in simultaneous cut are fitted with only a single tool post ; a hand is attending but a single machine, or perhaps two machines, where he might as easily, or even more easily, attend four, six, or eight machines, each doing as much as or more than the single machine which now occupies the entire time of the almost idle workman. It is only in the last ten or fifteen years that the haughty machinist has condescended to overlook two machine tools at work, but now the cry of "spoiling trade," and even the theory that the smaller the day's work performed the more days' works there are to be done, have been abandoned by the greater part of machine-shop workers, and there is no objection to increasing production by having one man attend all the machines possible.

Nothing here advanced applies to the repair shop, or, strange to say, to the river-boat engine shop. The repair shop demands nothing more than fairly efficient tools in as great a variety as possible, but both the repair shop and the river-boat engine shop, and indeed the general machine shop except for very heavy work, are rapidly passing out of existence ; they will not disappear entirely, but they will never again be of great importance.

Supposing a machine shop, having its established line of work in demand, to be well lighted, floored, ventilated, capitalized, and suitably supplied with cranes and hoists, and generally so equipped as to avoid all needless losses in transportation and handling materials and work in progress, and supposing it to have a plant of metal-cutting tools bought ten or twelve years since, which are still in fair working condition,—what course is dictated by real economy?

Each hour of labor should give the largest attainable result in finished product. Upon this axiom manager and superintendent are agreed. From this common base line, however, they travel in lines separated by a wide angle of divergence. The manager wants to use the old tools, while the superintendent wants to put the respectable, well-preserved, antiquated money-eaters in the scrap-heap or the second-hand dealer's warerooms, and install the best he can buy or build in their place. The manager knows the old tools are good enough; the superintendent knows they are not worth shop-room as a gift, or even that they would not be worth taking as a gift with a yearly bonus of ten or twenty or thirty thousand dollars added.

In this case, which is common enough, the wise superintendent will select the most general operation in the shop,—lathe work, boring, planing, drilling, or whatever it may be,—and quietly either alter an old tool to his mind, or buy one new tool of the greatest possible efficiency for that particular purpose; he will put an ambitious young man or cub on this tool, and tell him to show the old hands what he can do; he will double, treble, or quadruple his former per hour output. Cost cards will be compared by the manager, who will probably, if the superintendent shows a disposition to rest on his success, begin to urge the adoption of means to make like savings throughout the shops, although he would have previously opposed any change, and so the tool-replacing is inaugurated.

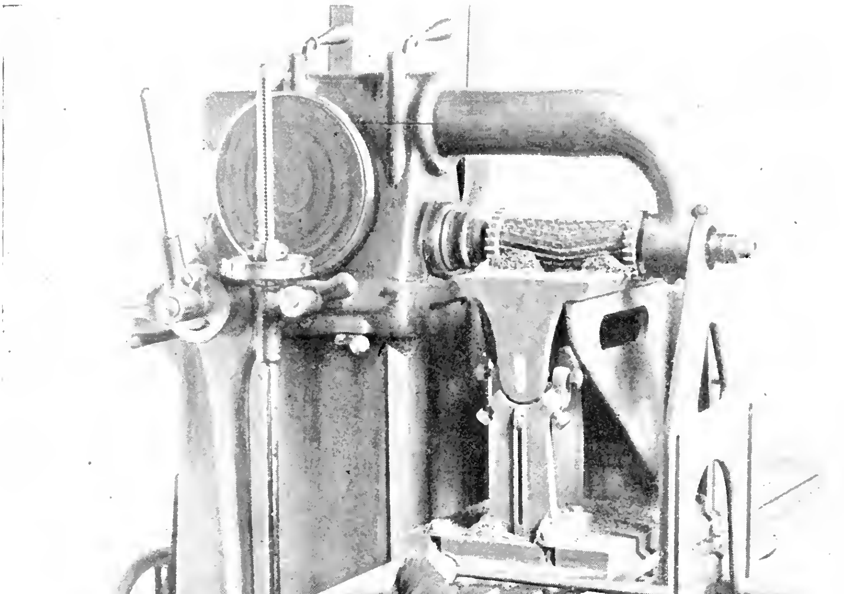
Suppose an engine lathe costs $500, and money is worth 5 per cent., and that the tool depreciates 10 per cent. yearly. and so becomes valueless in ten years; suppose also that the yearly wage of the workman who runs this lathe is $500. The total cost of this lathe for its lifetime is $750, exclusive of driving power, belting, repairs, and shop-room, and the total cost of labor to run the lathe is $5,000. Suppose this lathe finishes 20 short shafts daily, two cuts over, ready for filing and polishing, with a single tool, finishing cut followed with the callipers, 300 days in the year, 60,000 shafts in its lifetime costing $5,750.00÷60,000=$0.09416, or nearly 9½ cents each for lathe work. The management resolves to make better work for less money. The tool cost is $750, and labor cost is $5,000 for the life of the tool; obviously any great gain must be made by labor-saving, as the tool cost is small. The belt cone with 4 steps for a 2″ belt is replaced by a 2-step cone for a 4″ belt, another tool post is added on the back side with an inverted tool, and a hollow-mill sizer is placed in this tool combination to follow the two tool cuts, so that one cut over finishes the same shaft in half the time, and the workman does not need to follow the finishing cut with the callipers; as it takes but one minute to change pieces in the lathe, he has time to spare; he is offered the work at piece prices, and is willing to exert himself to increase his own earnings: four similar lathes are added, making a total of five, each finishing forty shafts per day, a total of 200 daily, 60,000 yearly, or 600,000 for the ten years' life of the plant; there is an added charge for tool-making and power and shop-room, but these items make but a small aggregate; the management is liberal in its views, and permits the workman to double his pay and earn $1,000 yearly. Flooded lubrication of the work and the balanced cut of the two tools make the lathes last as long as before, though doing twice the work. The total cost for ten years is 5 lathes, $500 each, $2,500; interest, $1,250; labor, $10,000; total, $13,750 as the cost of finishing 600,000 shafts, or a little less than $2\frac{3}{10}$ cents per shaft, against the original cost of about $9\frac{1}{2}$ cents each, or a saving of, say, 7 cents on each piece=$42,000 total saving on 600,000 shafts, or a yearly saving of $4,200, while the workman's pay has been doubled. By the first conditions the yearly product was 6,000 shafts at a total cost of $575; with the improved plant 6,000 shafts cost $138. This hypothetical case was almost exactly paralleled by the Mason Machine Shop with special lathes for finishing carding machine cylinders. I have not the exact figures, but believe the percentage of gain to have been greater in the real than in the supposed case, which is given because its simplicity makes it easily understood. First, the work must be wanted; next, driving power must be increased both in the office and the shop; finally, one man's labor must be made cover the use of more cutting edges. The work of each cutting tool edge may be increased vastly beyond the practice of some shops. In other shops machine tools and labor conditions are such that each cutting tool is made to do all it can. Every agent of production has its limit of effect, and the most economical results are obtained from use well within the powers of the agent, whether the agent be a man, or a horse, or a driving belt, or the cutting edge of a metal-working tool. The best practice possible consists broadly in furnishing ample driving power, rigid tool support, multiple cutting edges, and in many cases, and possibly in all cases, flooded lubrication of cuts in progress. No experiments are recorded of the effect of lubrication on cuts in cast iron, which is still cut dry; until very lately, it was supposed that different metals required different lubricating materials, but the latest and best automatic screw-machine practice proves conclusively that flooded lard-oil lubrication is best for iron, steel, and wrought and cast brass, although brass is still worked dry in many and perhaps in the majority of cases. The best screw-machine practice within my knowledge is that of the Lozier Cycle Shops, at Thompsonville, Conn., where the whole place is piped with the best lard oil from a single set of pumps, and all cuts of every description are flooded with this single lubricant. Forced lubrication is indispensable in some cases, and a most important aid to economical production in all cases, high pressures of 200 pounds to the inch or more being essential to the best production of some cuts. Water, and soda-water, and soap and water, can be used to great advantage on heavy work, but it is not in heavy work that enormous savings in finishing and cost can be made, although it is highly probable that steam-engine finishing now costs but little more than half, or possibly but little more than a third, what it did ten years ago. Seven thousand horse power of Corliss engines was lately contracted at 3½ cents per pound, which indicates recent great reductions in labor on work of this class. The modern large boring mill, with two or three cutting tools in simultaneous operation, greatly cheapens the cost of a large class of work. The iron planer has had its effectiveness increased in two ways,—by increasing the number of tools, and the length of the bed, so as to permit the placing of many short pieces at once. In some cases twelve or eighteen planer tools are in simultaneous cut on one planer; in other cases, one man attends several planers; in other cases, the piece-worker abandons the use of automatic feeds of uniform width, and feeds the tools by hand for roughing large work. At the Baldwin shop locomotive frames are planed two at a time, on special Sellers planers, at an incredibly low cost. At the Hendey Norton Lathe Shops, Torrington, Conn., a six-foot engine lathe bed is sometimes planed for less than one dollar, on a special long table machine, with several tool-carrying heads. Lack of space forbids particulars, no matter how interesting or pertinent. I can do no more than simply assert the bare outlines of most advanced practice: the lowest-cost work is being constantly cheapened, and the factors of cost reduction are rigid tool support, abundant driving power, multiple cutting edges, and forced lubrication. These things are perfectly recognized and fully understood by some managers and superintendents of to-day, and machine-tool makers are being gradually forced to meet the requirements of such buyers. I use the word "forced" advisedly. The good and successful machine-tool builder must follow the public demand. He cannot create it, and cannot hurry it.

As for the users of old tools, the managers who proudly cherish and tenderly preserve a museum of machine-tool antiquities, nothing can improve their condition short of a sheriff's sale. Such shops may earn a living at repairs and foundry jobbing by carefully pottering along in the old tracks with a constantly-diminishing force of grey-haired and spectacled old-time machinists, standing to-day where their feet wore holes in the floor twenty or thirty years ago; or they may close the doors over their grass-grown thresholds in silent confession that they are distanced in the race. There are hundreds of such shops in the country, and there is but one fate for all of them. They must change or quit. And it is not enough to put in here and there a new tool among the hoary wrecks which they dignify by the name of "tools," as in a case which I saw very recently, where a large Gisholt turret chucking machine stood at one end of the machine floor and a Cincinnati Milling Machine Company's milling machine and cutter grinder at the other end, and nothing of later date than 1870 between them. "Times are not what they used to be," said the old man in the neglected office: "business is dull."

Powerful drillers, banked for the smaller work, radial and provided with pits, large sole plates, and work carriages for heavy work; multiple tool boring-mills and planers, the later with 30- or 40-ft. tables where demanded; modern chucking machines, and pulley and wheel-finishing machines, making from three to five simultaneous cuts; turret machines of all classes, from the Brown and Sharpe "pony" to the heaviest Niles or Gisholt: the flat turret lathe in its late form, and that yet unknown quantity, the milling-machine, now built in its heaviest patterns by Ingersoll,—these are the factors of cheaper machine work within reach of the ambitious superintendent to-day. For work which must approach accuracy the grinding-machine is indispensable, and the various forms furnished by Brown & Sharpe, Landis, and others can be relied upon to produce really good work more cheaply than will any other means.

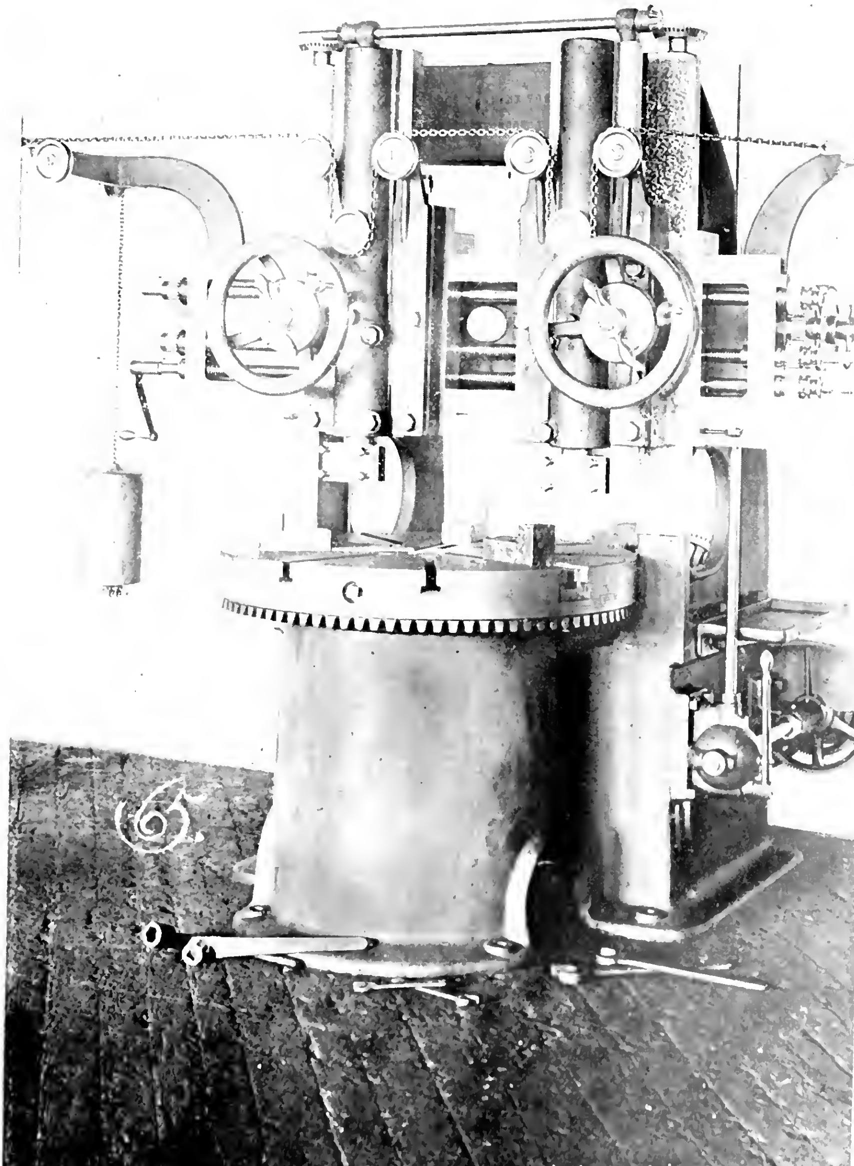
To reach the most economical production both manager and superintendent must rise above that conservatism which is but the natural indisposition of the human mind to admit the superiority of others. The manager must desire cheaper and better work, and the superintendent must find tools and men to gratify this desire, and both must understand that the success of yesterday has passed never to return, and must fully and faithfully believe that the dream of to-day may be the wealth-producing fact of to-morrow.

NOTE.—The illustrations for this article, representing advanced types of metal-cutting machinery, are bunched on the following pages.



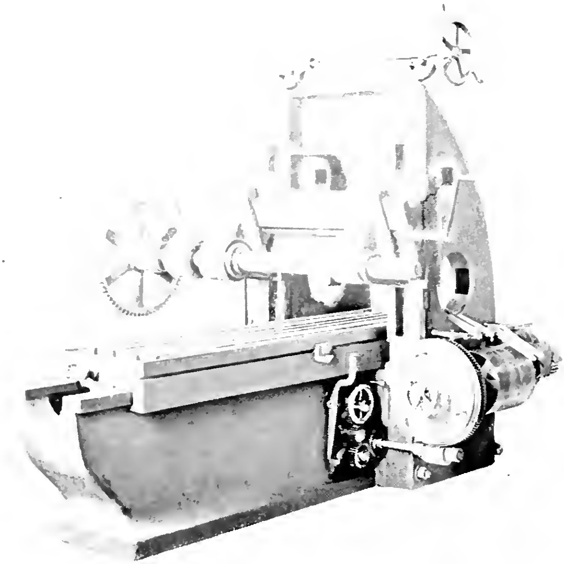
NO. 24 PLAIN MILLING MACHINE,

In operation on Milling Machine Knee. Brown & Sharpe Mfg. Co., Providence, R. I.

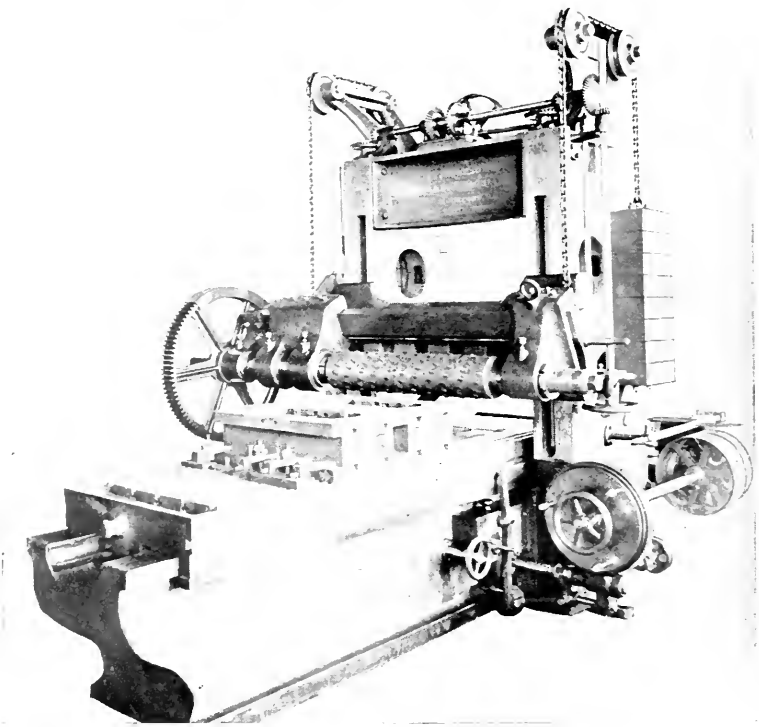


37" BORING AND TURNING MILL, WITH TWO HEADS.

Bullard Machine Tool Co., Bridgeport, Conn.

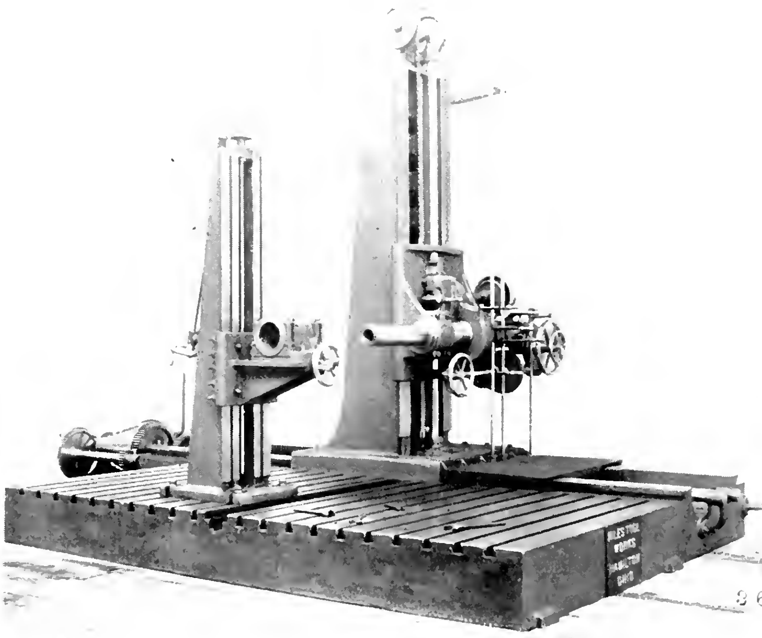


INGERSOLL SLAB MILLING MACHINE, 24" X 24" X 72".

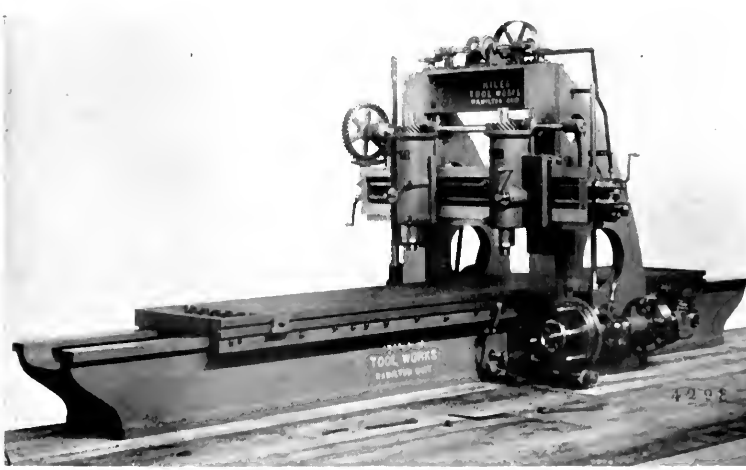


INGERSOLL PATENT SLAB MILLING MACHINE,

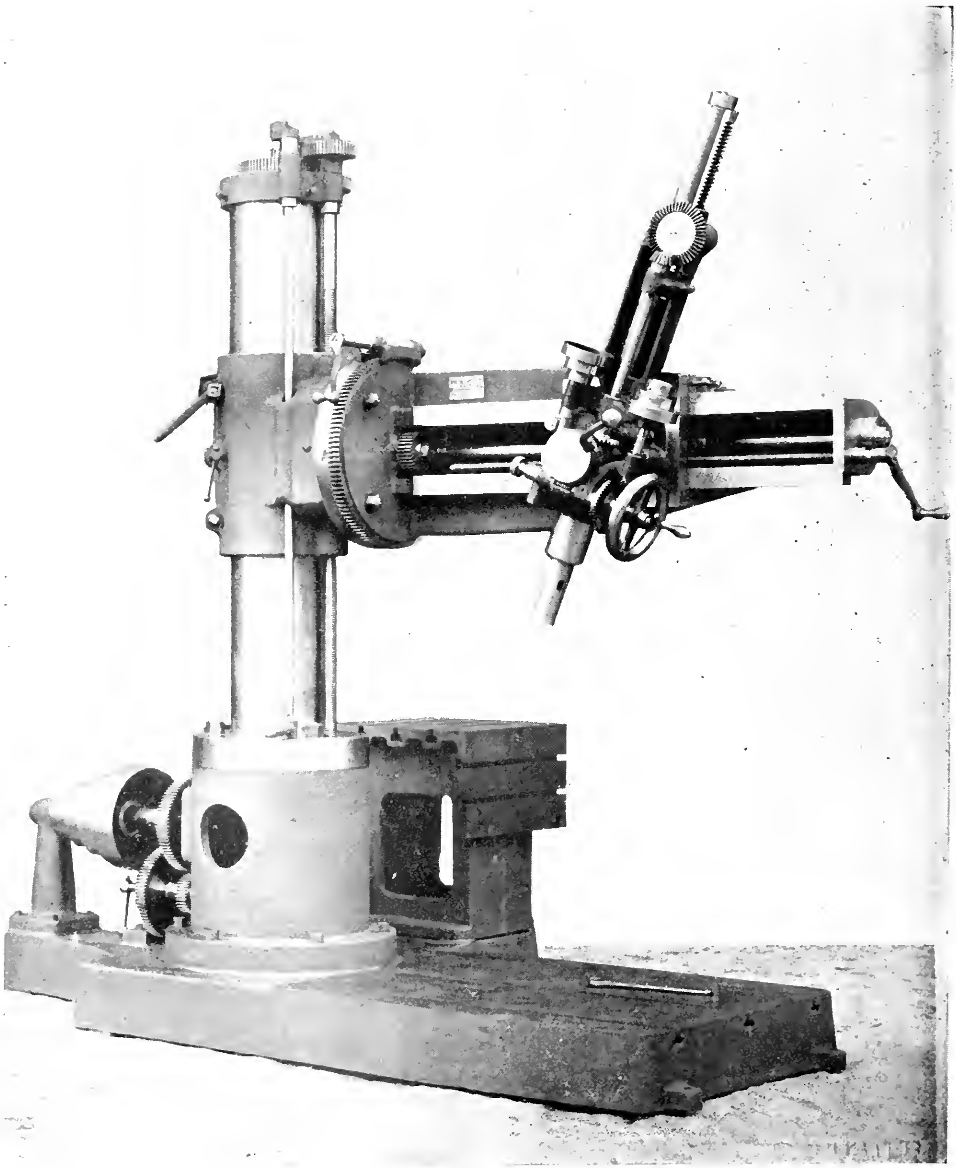
With Ingersoll Patent Cutter, shown milling 30" wide, 4" per minute. Ingersoll Milling Machine Co., Rockford, Ill.



HORIZONTAL MILLING AND BORING-MACHINE.
Niles Tool Works, Hamilton, Ohio.

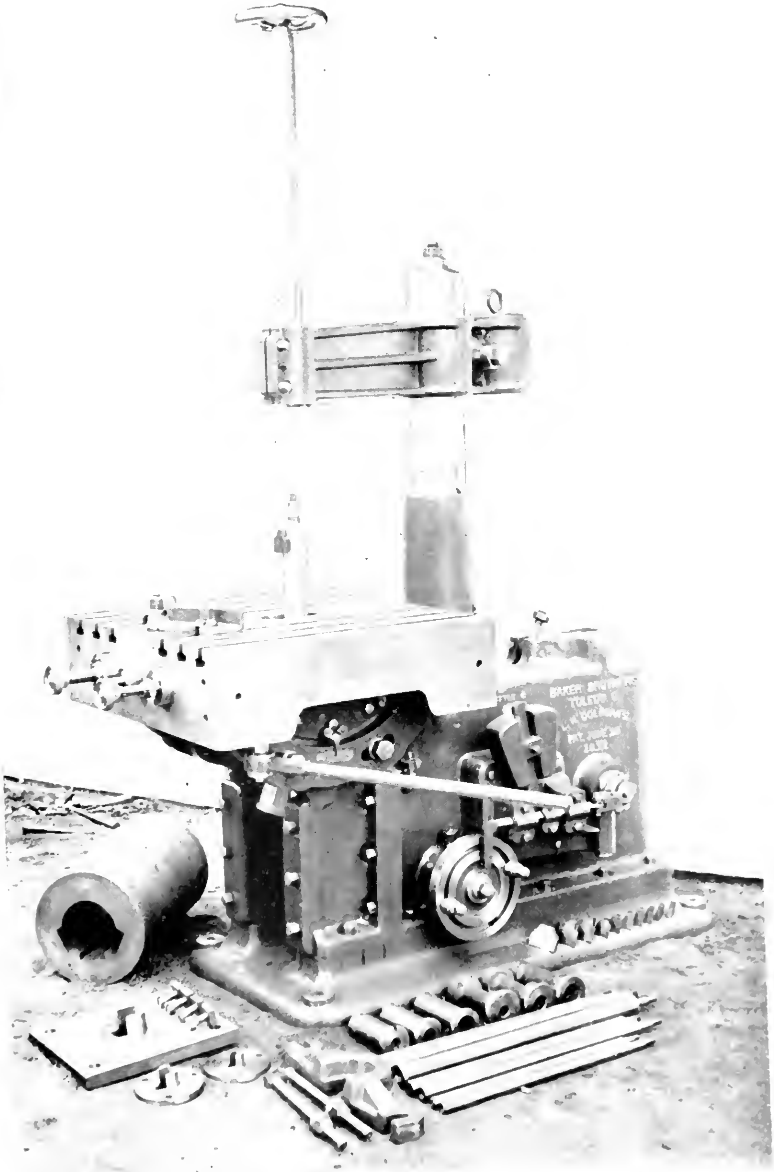


DOUBLE-SPINDLE VERTICAL MILLING-MACHINE.
Niles Tool Works, Hamilton, Ohio.



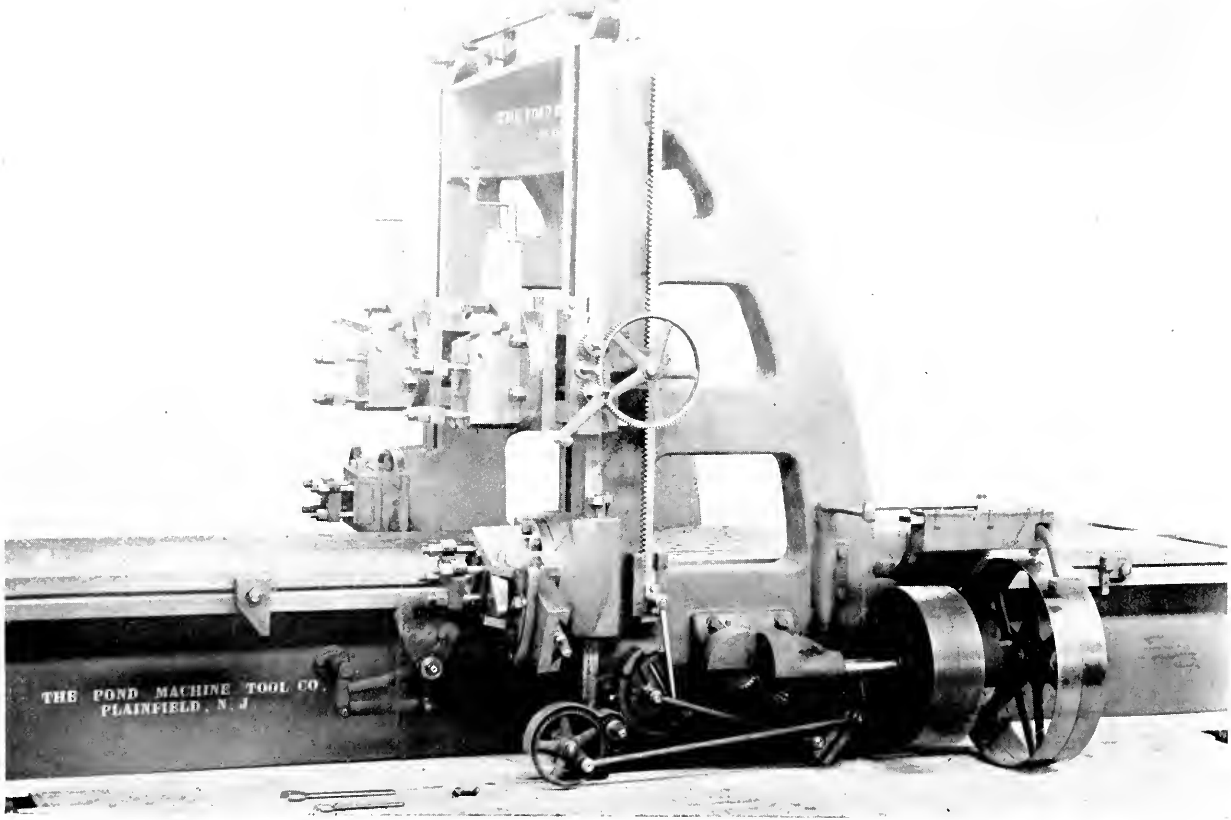
FULL UNIVERSAL RADIAL DRILL.

Bickford Drill & Tool Company, Cincinnati, Ohio.



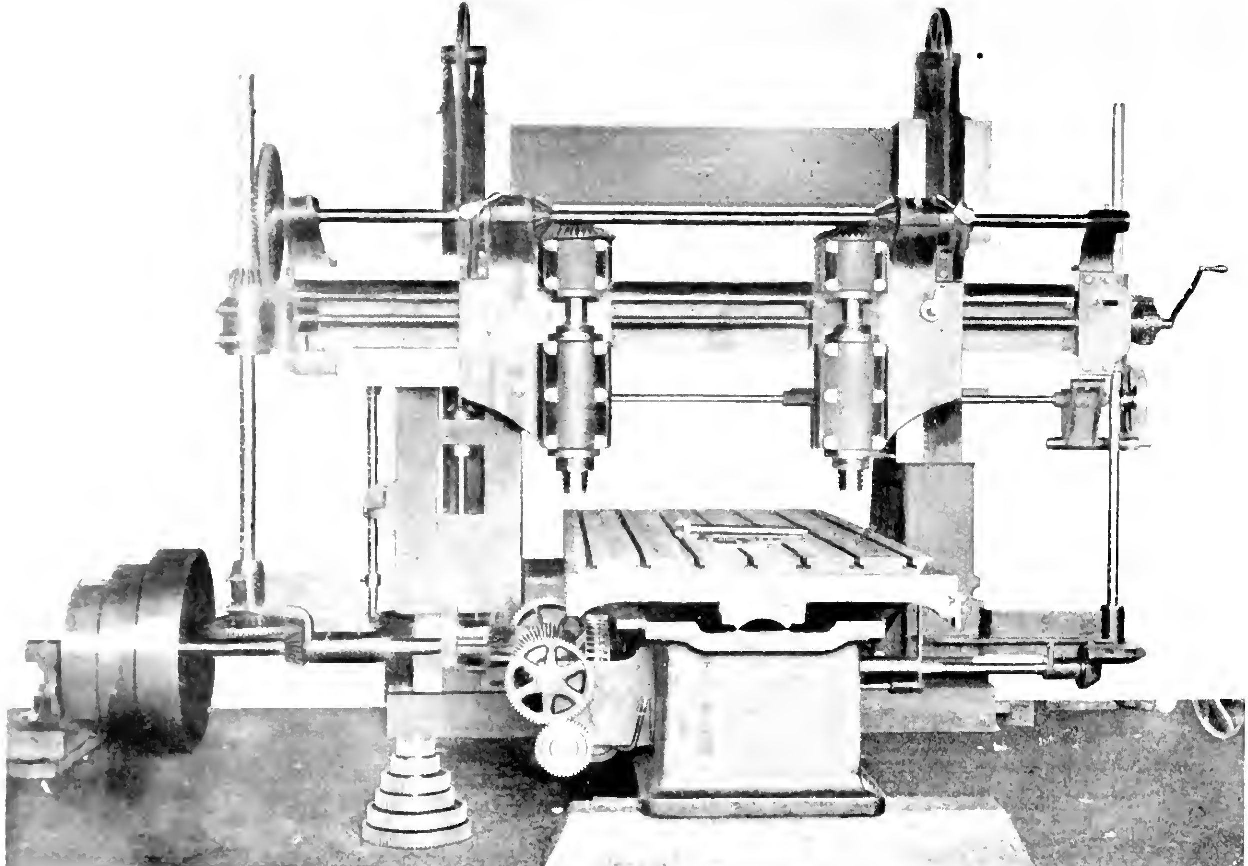
COLBURN KEYWAY CUTTER

Baker Bros., Toledo, Ohio.



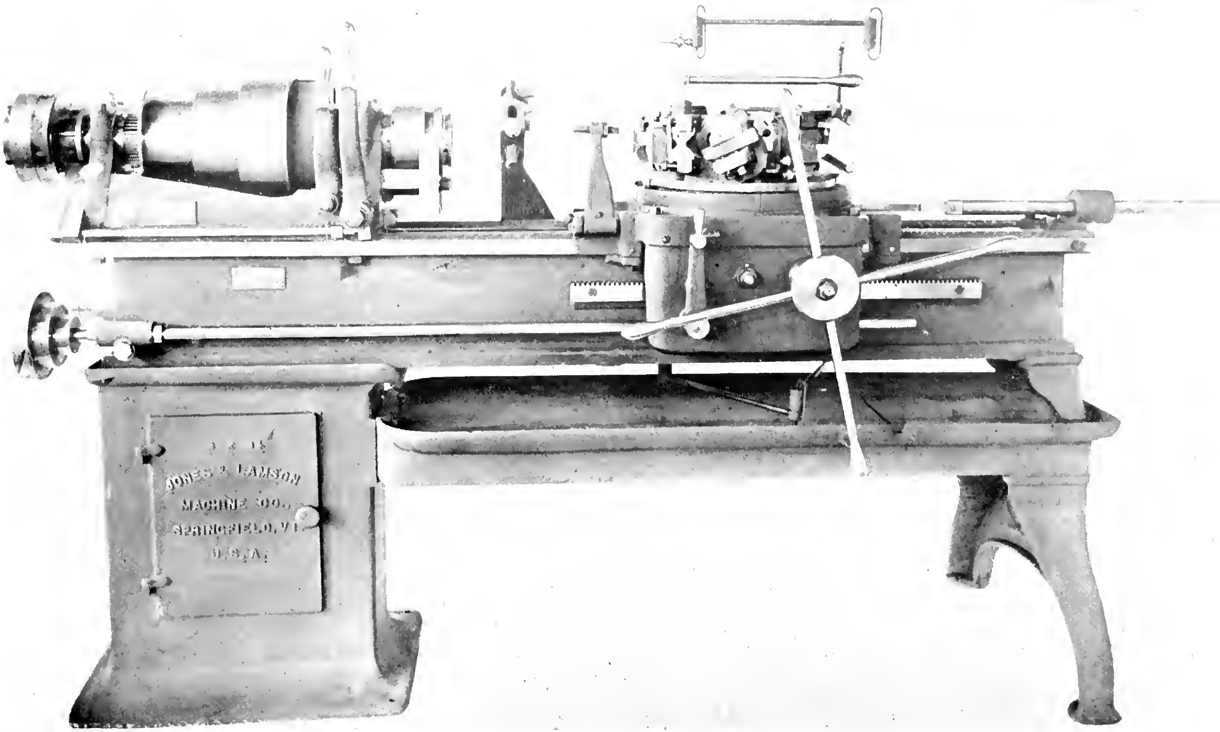
60″ PARALLEL PLANER.

Pond Machine Tool Co., Plainfield, N. J.



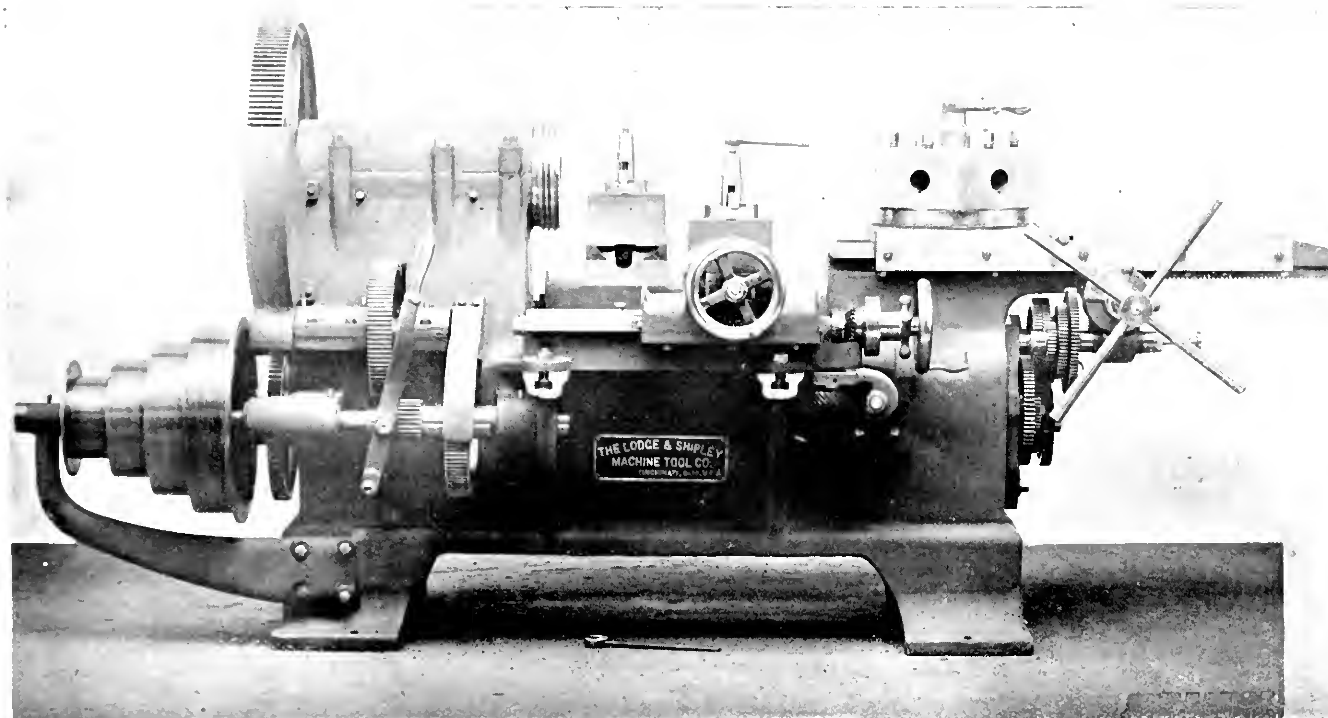
DOUBLE VERTICAL SPINDLE MILLING MACHINE.

Pratt & Whitney Co., Hartford, Conn



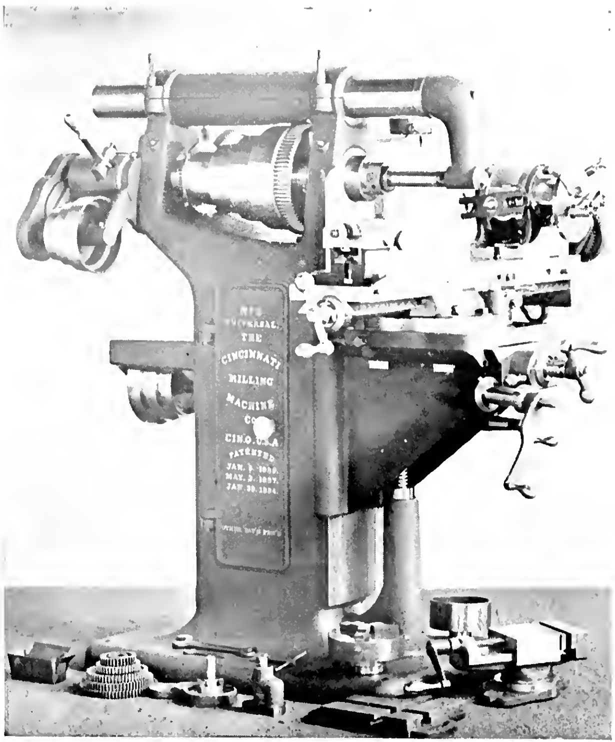
HARTNESS PATENT FLAT-TURRET LATHE.

Jones & Lamson Machine Co., Springfield, Vt.

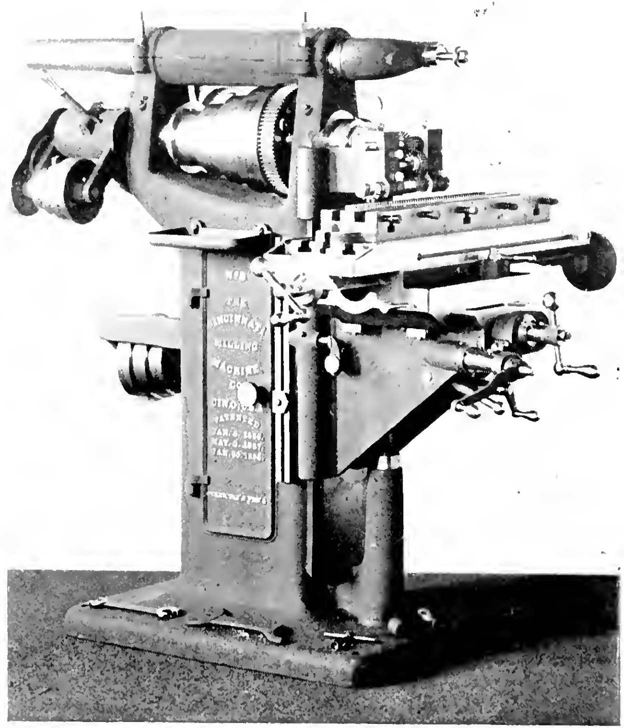


30" DOUBLE-SADDLE TURRET LATHE.

Two Independent Tool posts and Six Hole Turret; Independent Feeds. Lodge & Shipley Machine Tool Co., Cincinnati, Ohio.

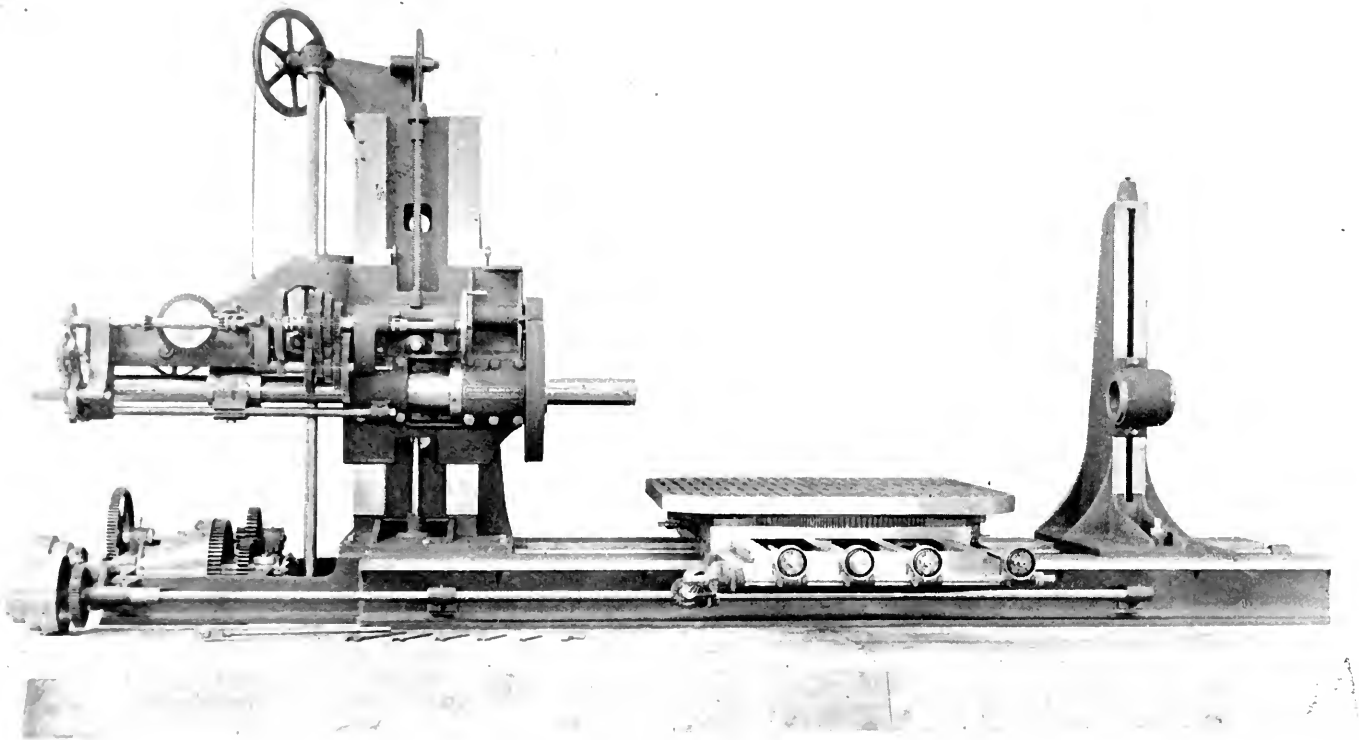


UNIVERSAL MILLING MACHINE.



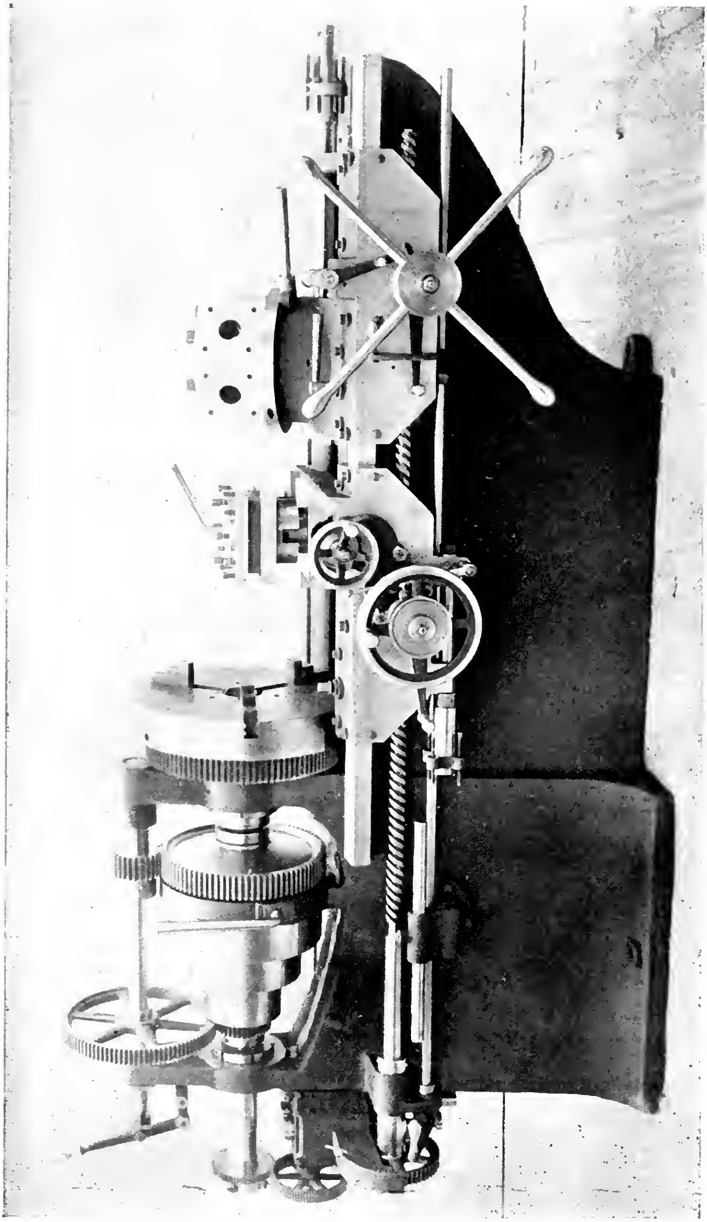
PLAIN MILLING MACHINE WITH AUTOMATIC FEEDS IN ALL DIRECTIONS.

Cincinnati Milling Machine Co , Cincinnati, Ohio.



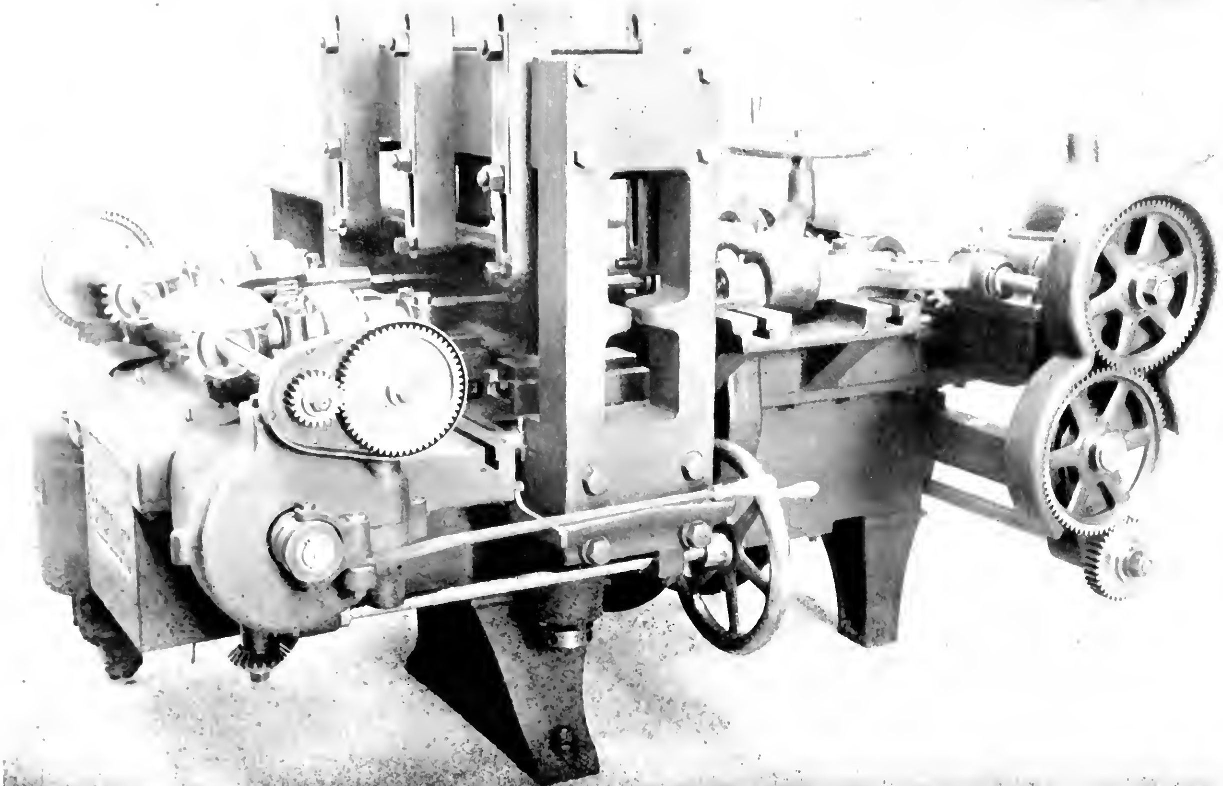
SCREW-CUTTING UNIVERSAL MILLING MACHINE WITH TRAVERSING TABLE.

Bement, Miles & Co., Philadelphia, Pa.



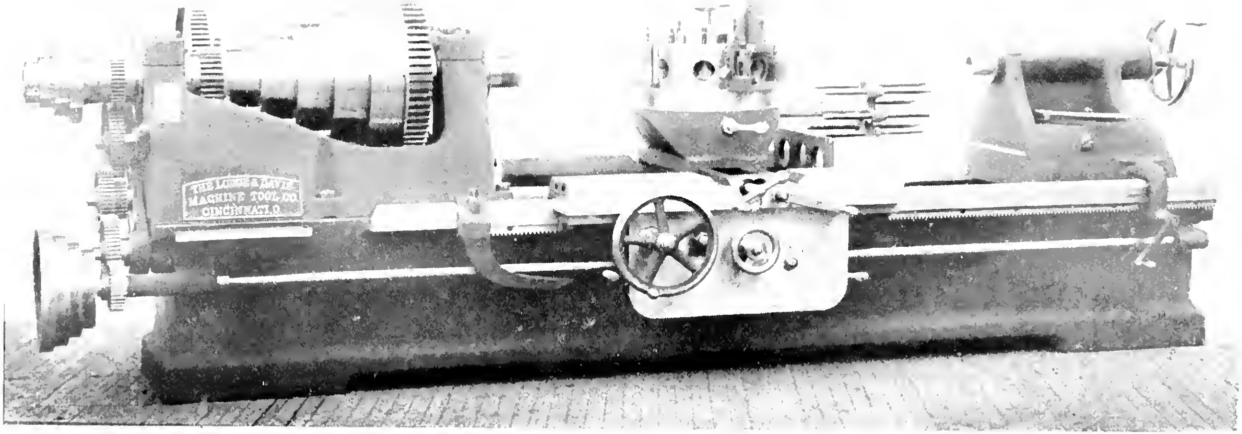
STANDARD FRICTION-HEAD TURRET LATHE.

Gisholt Machine Co., Madison, Wis.

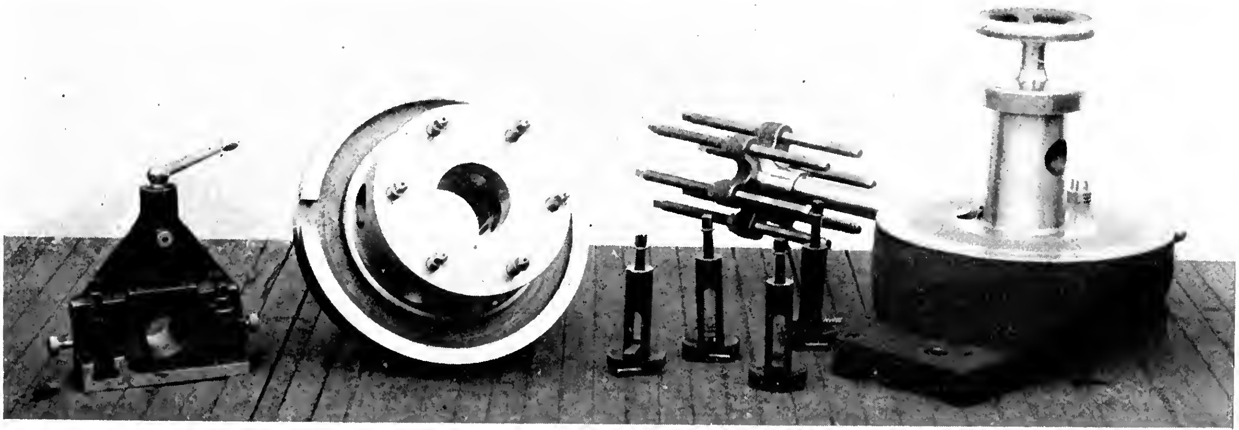


FIVE-SPINDLE HORIZONTAL RAIL-DRILLING MACHINE, FOR ELECTRIC RAILWAY CONSTRUCTION.

Wm. Sellers & Co., Incorporated, Philadelphia, Pa.



36" LATHE FITTED WITH COMBINATION RING TURRET, FOR MAKING STUDS, BOLTS, ETC. UP TO 3" DIAMETER.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.



DETAILS OF TURRET MOUNTED ON LATHE ABOVE.

THE IMPORTANT FUTURE OF PRODUCER-GAS.

By A. Humboldt Sexton.

THAT producer-gas has failed to take the position in the world of manufactures which those familiar with its advantages think that it deserves can hardly be denied. It is universally used for firing open-hearth steel furnaces, and in a few other operations where high temperatures are required it has to some extent come into use; but in the majority of our manufactures it is very little used, and for steam-raising and similar purposes its value has hardly been recognized. Yet for many purposes—probably for most—it has very decided advantages over solid fuel, both as regards convenience and economy. That the importance of these advantages has not been fully realized is evident, and for this there must be some good reason. Is it that the manifest advantages of gaseous fuel are accompanied by less obvious disadvantages, which to ordinary fuel-users more than counterbalance them? And, if so, are these disadvantages inherent in the fuel itself, or are they due to the use of unsuitable and defective forms of plant? Or is the neglect due merely to innate conservatism which makes most people loth to change the methods of work to which they have been accustomed?

That there are certain disadvantages attending the use of gaseous fuel may be admitted, but they are so few and unimportant that they cannot weigh against the many advantages; the writer feels, therefore, that the small progress which has been made in the use of gaseous fuel has been very largely due to the unsuitability of much of the plant that has been employed,—for, unfortunately, very few of the gas-producers at present in use allow anything like a full realization of the convenience and economy of gas-firing.

On studying the various patents which have been taken out for gas-producers, one is at first appalled by their number; but this feeling is soon replaced by one of wonder at the extraordinary lack of originality shown by the patentees, and at the evident ignorance of most of them of the principles on which gas-production is based. Most inventors seem to content themselves with merely modifying or improving (?) in details forms already in use, while but few go back to first principles, study the nature of the various operations, and consider how best these may be applied to the case in hand. Too often also the attempt is made to make a producer which will give gas suitable for all purposes rather than for one special purpose, regardless of the fact that what is best for one purpose may be worst for another, and that it is impossible to design any form of plant which will be equally good under all conditions.

That a plant may be successful, it is, above all, essential that it should be economical in working. The first cost is of little moment since it is incurred once for all; but the cost of up-keep and repairs must be low, and the less labor required the better. The gas produced must be as rich as possible in combustible constituents, it must be suitable for the purposes for which it is required, and the expenditure of energy in the conversion of the solid fuel into gas must be kept at the lowest possible point. This can be done only by minimizing all sources of heat loss.

The theory of the manufacture of producer-gas is very simple, but a brief consideration of it may be useful. The simplest possible form of producer is undoubtedly the early Siemens type, which for a long time was largely used, and which even now is not quite extinct. It consisted of a rectangular chamber of fire-brick provided at the bottom with fire-bars and at the top with a tube for carrying off the gas and a hopper for charging the fuel. The grate was open to the air, and the draught was produced by a chimney.

Assume such a producer at work, using coke or charcoal as fuel, and no steam being used. The air entering would burn the carbon to carbon monoxid and carbon dioxid, and the latter, if the producer were working perfectly, would be decomposed by the hot charcoal, forming carbon monoxid, so that the escaping gas would consist only of carbon monoxid and nitrogen, and would contain 34.7 per cent. of the former. Such a gas would have a very low calorific power, and its production would be extremely wasteful, as about one-third of the heat which the solid fuel was capable of giving would be evolved in the producer, and thus lost for all practical purposes. There is considerable misapprehension as to the nature of this loss of heat in the production of producer-gas. It is often spoken of as if it were heat absorbed or rendered latent, as is the case when water is boiled into steam. It is, however, quite different; heat is not absorbed, but evolved; only, it is evolved in the producer, where it is not wanted, instead of in the furnace, where it is wanted. Therefore it cannot be used to advantage.

In order to secure economical production, the gas must be enriched, and at the same time the evolution of heat in the producer must be reduced to the lowest point. Both these objects are secured by the use of steam. When steam comes in contact with hot carbon, it is decomposed, and yields equal volumes of carbon monoxid and hydrogen. The amount of carbon monoxid produced is the same as if the carbon were burned by air, but, instead of being mixed with about twice its bulk of inert and incombustible nitrogen, it is mixed with its own volume of combustible, strongly-heating hydrogen ; if it were possible to use all steam and no air, the gas would be what is commonly called water-gas. The decomposition of the steam, however, absorbs a very large quantity of heat, and, therefore, if too much be blown in, the action would stop, or, at any rate, be seriously modified. The heat is absorbed in producing these combustible gases, which, by burning in the furnace, give out the heat again, thus serving as carriers of heat from the producer, where it is not required, to the furnace.

The amount of steam that can be used is limited, for, owing to the absorption of heat, if too much be blown in, the action will not go on satisfactorily. If too much steam be used without abundance of air, the cooling will be so great as to stop the action altogether ; if sufficient air be supplied at the same time, the cooling will be less complete, but a large quantity of carbon dioxid will be formed, and much steam will pass through undecomposed, thus carrying away a large quantity of heat. By the judicious use of steam the loss of heat in the producer may be reduced to about fifteen per cent. of the heating power of the fuel.

The gas may be further enriched by the use of coal, instead of charcoal or coke, as assumed above. The coal is thus distilled, and the products of distillation mix with the producer-gas, the amount of added gas varying from a trace with anthracites up to nearly ten per cent. with very bituminous coals.

The sources of loss of heat in gas-production are due :

(1) To undue evolution of heat in the producer by formation of carbon dioxid ;

(2) To loss of heat from the producer itself,—

(a) Carried away by the gases,

(b) Lost by radiation,

(c) Carried out in the ashes,

(d) Used in distilling the coal.

As it is necessary to keep up the temperature of the producer to the point at which combustion can take place, the greater the amount of heat lost, the smaller is the quantity of steam which can be used. It is obvious that the losses can never be reduced to nothing ; if they could, once the producer was started, the heating power of the gas would be equal to that of the solid fuel from which it was produced. This is impossible, and so the heating power of the gas is always less than that of the solid fuel by an amount which will be greater, the greater the loss of heat in the producer. When carbon monoxid is being produced, the evolution of heat in the producer, as remarked, is about one-third of that which the solid carbon would give ; but, immediately carbon dioxid is produced, the loss becomes very much larger, being, of course, evolution in the wrong place. Not only does it do this, but it impoverishes the gas, robs it of its chief combustible constituent, and increases the quantity of inert nitrogen. Carbon dioxid occupies the same volume as a quantity of carbon monoxid containing the same amount of carbon; but, as it contains twice the amount of oxygen, its production adds twice the amount of nitrogen to the gas. As already remarked, if, in a producer fed with charcoal, all the carbon were burned to carbon monoxid, the producer-gas would contain:

Carbon monoxid	34.7
Nitrogen	65.3
	100.0

If, however, one-third of the carbon were burned to carbon dioxid, the composition would be:

Carbon monoxid	19
Carbon dioxid	9.5
Nitrogen	71.5
	100.0

This amount of carbon dioxid is frequently present in producer-gas. Under these circumstances the heat evolved in the producer, and therefore lost, would be about fifty per cent. of that which the solid carbon could give, if completely burned.

It is obvious, therefore, that in gas-production it is of the very utmost importance to prevent the formation of carbon dioxid, and no producer can be efficient which allows more than a trace of this to be produced.

The amount of heat carried away by the hot gas leaving the producer is very large, and, without an exceptionally high temperature, may reach ten per cent. of the heat which the fuel can evolve, or one-third of that given off in the producer when no steam is used; if steam is escaping with the gas, the amount may be very much more. The heat carried away is in most cases lost, as the gases cool before entering the furnace, and, if regenerators are used, nothing is gained by sending in the gas hot. Obviously, therefore, the gas should be cooled to the lowest possible temperature before it leaves the producer, and this can best be done by passing the gas through a thick layer of fuel, to which it can give up its heat.

The loss of heat by radiation is also large; the larger the radiating surface in proportion to the heat evolved, the greater will be the loss.

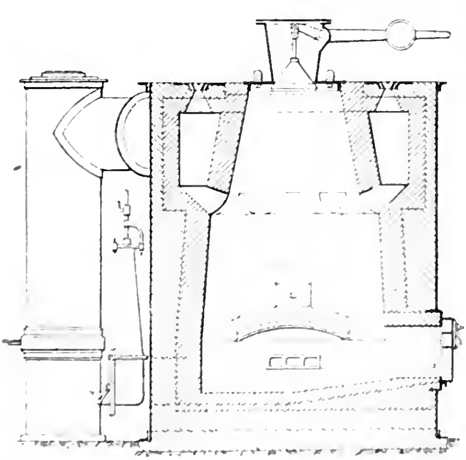
The loss by the fall of hot ashes is small, but in bar-bottom producers there may be considerable loss by the fall of unconsumed fuel through the bars.

The heat absorbed by distillation of the coal is small, and may be neglected in the comparison between solid and gaseous fuels, because, even when coal is burned on a grate, the gas distills out before it burns. The gas-producers at present in use fall into two chief groups,—those used with a natural draught, and those used with a blast.

(1) Producers worked by natural draught. Of these the first Siemens producer may be taken as a type. The draught was obtained by passing the gas through a long overhead cooling tube. The cold gas in the vertical portion farthest from the producer, being heavier than the hot gas in the portion near the producer, acted as a siphon, and produced a current. The grate-bars were open to the air, so but little steam could be used. The gas, therefore, was poor, and, as the layer of fuel was thin, often contained a considerable quantity of carbon-dioxid. This type of producer has now been almost completely abandoned. It was not efficient, and the fuel consumption was only about fifteen pounds per square foot of grate area per hour.

(2) Producers worked by draught. Of these there are three distinct types.

(a) Bar-bottom producers. In these the fuel rests on fire bars beneath which the air is blown. They vary much in form, but differ from the class already described in the fact that the hearth is closed. They are usually of small size, and the consumption of fuel is small. This type of producer has been almost entirely abandoned in Great Britain, except for small installations, as it is much less efficient than other types. For small plants producers of this form are handy, as they are easily managed. (b) Solid-bottom producers. In these there are no grate-bars, but the ashes rest on the solid bottom of the producer, and the air and steam are blown into the center of the mass. These are the most popular producers in Great Britain, the best known form being the Wilson. A much greater pressure of steam can be used with this class

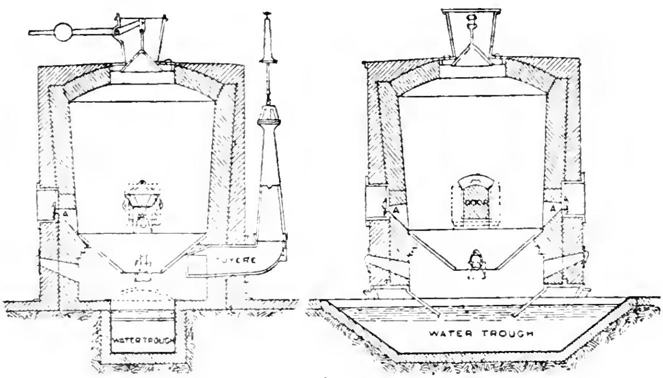


THE WILSON PRODUCER.

of producer, and a more rapid combustion can, therefore, be obtained, many producers burning as much as forty pounds of fuel per square foot of bottom per hour. They can be made of considerable height, and, owing to the high temperature that can be obtained, the gas contains very little carbon dioxid. They may be built separate or in block, the latter being usually the most economical.

One objection to most solid-bottom producers is the necessity for stopping periodically for the removal of the ashes. This difficulty has been overcome in the Wilson Automatic, Taylor revolving bottom, and some other producers.

(c) Water-bottom producers. These are solid-bottom producers in which the ashes are received in a vessel of water, the sides of the producer being carried down into the water far enough to form a water seal, and prevent the escape of gas, and to allow the withdrawal of the ashes below. The lower portion of the producer is usually made conical, and may be solid, or in the form of a hanging grate. The air and steam may be blown into the center of the fuel by means of a steam pipe, but usually they are supplied to a space between the annular grate and the casing, so that they pass up through the hot ashes. These producers are efficient, and are rapidly coming into use. The heat of the ashes is utilized in evaporating the water, and they are easily cleaned. The best known producer of this type is the Dawson.



THE DAWSON PRODUCER.

All the producers described are usually made low, being rarely more than twelve to sixteen feet in height. The gases, therefore, leave at a high temperature, and very frequently contain carbon dioxid in considerable quantity. The only way in which the heat carried off by the gases can be saved is, as already remarked, that of making the column of fuel higher; and the only way to prevent the formation of carbon dioxid is to increase the zone in which the temperature is high enough to ensure its decomposition by the hot carbon.

When these changes have been made, the producer will approach very near to a blast furnace in type.

The blast furnace is, in many respects, an ideal gas-producer. The gas from an ordinary iron-smelting blast-furnace contains a large quantity of carbon dioxid produced by the reduction of the iron oxid; but even then it compares favorably with some producer-gases, and can be used for all purposes for which gaseous fuel is required, including steel-making in open-hearth furnaces and driving gas engines. If there were no reducing reactions to take place, the gas would contain no carbon dioxid. In ordinary producers the ashes are drawn out solid; in a blast-furnace producer they are melted and tapped out. The fluxing of the ashes might necessitate the addition of a small quantity of limestone, but the carbon dioxid from it would probably be decomposed at the temperature at which it was separated. With a blast furnace the fuel-consumption, and, therefore, the gas-production, is very much larger than in ordinary producers. A blast furnace of moderate size will consume two hundred pounds of coal per square foot of bottom per hour, reducing the sources of loss to a minimum.

The writer is convinced that it is in the direction of approach to the blast-furnace type of producer that we must look for future developments in gas-production; and, curiously enough, this would be reverting to one of the very earliest forms,—that of Ebelman.*

Coal is now almost always used in gas-producers, and, when it is subjected to destructive distillation, a large quantity of tarry matter is produced, which has sometimes proved troublesome; therefore, many attempts have been made to destroy or remove it.

When open producers were used with an overhead cooling tube, much of the tar was condensed in this; but, now that this has been abandoned, much of the tar is carried forward with the gas.

In the Wilson and some other producers the gas distilled from the coal is made to pass through the incandescent fuel, and the tarry matter is thus broken up into permanent gases and solid carbon. If the tar is to be removed, it seems more rational to condense it, and thus recover it and any ammonia that may be present.

Whether the tar should be removed or left depends upon the conditions under which the gas is to be used. There can be no doubt that the removal of the tarry matter reduces the heating power of the gas, but by how much it is quite impossible to say, as the amount of

* Mr. Ormiston of Glasgow published a pamphlet a few years ago, calling attention to the blast furnace as a gas producer.

tar which deposits and the amount which is carried forward by the gas are uncertain. Probably the reduction of heating power may be taken as being about ten per cent., though some workers have placed it as high as twenty per cent., or even more.

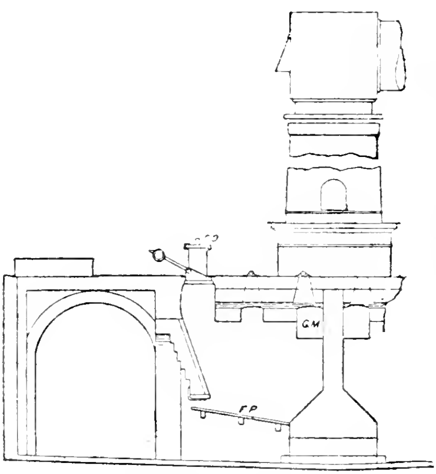
When the gases are passed through brick-lined or underground flues, so that they do not cool, there is still a deposition of tarry matter, which has to be burned out each week end; but the bulk of the tar is, no doubt, carried forward into the regenerators, there it is to a large extent decomposed with the deposition of solid carbon, which will be burned when the gases are reversed.

When used in regenerators, therefore, probably the tarry matter adds but little to the heating power of the gas, and may be safely removed and utilized in other ways. When the gas is to be used for boiler-firing and similar purposes without regenerators, the removal of the tar is, no doubt, very disadvantageous. If the producers are so placed that the flues are short, there will be very little condensation, and the tarry matter will be carried forward, adding to the heating power of the gas, and at the same time—what is of far more importance for this purpose—adding to the luminosity, and, therefore, to the radiative power, of the flame. It is difficult to conceive a more inefficient way of securing steam than the use of tar-free gas burning with a non-luminous flame under ordinary boilers.

For such purposes as reverberatory furnace and boiler-firing, where a radiative flame is required, it seems best to send the hot tar-laden gas direct to the furnace, and use an air regenerator for heating the air.

For use in gas engines the gas must be free from tar and dust, and should, therefore, be well washed.

Among recent suggestions for the use of gaseous fuel the furnace and producer of Mr. F. Siemens deserves notice. In this system the air only is heated by passage through a regenerator. The products of combustion are divided. One half is sent through the regenerator, the other half being sent, together with some air, into the producer. The carbon



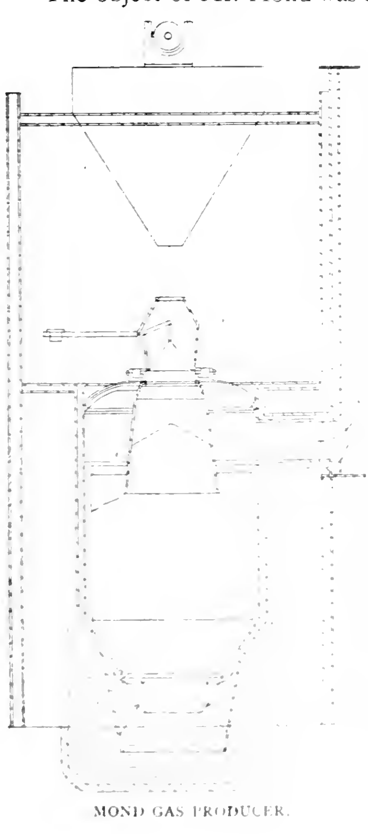
SIEMENS PRODUCER.

dioxid in the products of combustion is reduced to carbon monoxid, and the gases pass to the furnace at a very high temperature. These furnaces are being somewhat extensively used for reheating and similar purposes.

The writer thinks it would probably be more satisfactory, if four regenerators were used as usual, the air being heated in one and steam and air for the producer being heated in the other. In that way gas could be economically supplied at a very high temperature direct from the producer to the furnace.

Another method of making producer-gas has recently come to the front, and promises to be largely used in the future. The method was invented and patented some years ago by Dr. L. Mond, and has been recently taken up by Mr. J. H. Darby. The gas obtained by this process is very different from ordinary producer-gas, and may, for convenience, be called Mond gas.

The object of Mr. Mond was to obtain the largest possible quantity of ammonia, and in this he was eminently successful. Mr. Darby now obtains a gas of good quality, which has been successfully used for steel-melting and other purposes. The principle of the process is simply to blow in the largest possible quantity of steam, and so to produce a large amount of free hydrogen, under the influence of which, probably in the nascent condition, a large quantity of the nitrogen of the fuel is evolved as ammonia. The gas-producer is of the water-bottom type, with a conical grate through which the air and steam are blown. The amount of steam supplied is about two and one-half tons for each ton of coal consumed, and necessarily a large proportion of this passes through undecomposed. The gas leaves the producer at about 500° C., and is passed through cooling tubes, where a good deal of the water is condensed; then through an agitator, where it is mixed with cold



MOND GAS PRODUCER.

water; then up a lead-lined tower, where it meets a descending rain of sulphuric acid; then up another tower, where it is washed with cold water; and then to the furnaces, or engines, where it is to be used. The yield of gas from a common slack containing eleven per cent. of ash is about one hundred thousand cubic feet per ton, and its average composition by volume is:

Carbon dioxid	17.1
" monoxid	11.0
Olefines	.4
Methane	1.8
Hydrogen	27.2
Nitrogen	42.5
	100.0
Total combustible gas	40.4

The amount of ammonium sulphate recovered is about ninety pounds for each ton of coal consumed, the coal containing about 1.5 per cent. of nitrogen. Mond gas has been successfully used for various purposes, among others for driving gas engines, for which its freedom from dust and tar, and its high calorific power, render it specially suitable. While the first cost of the plant is high, the large amount of ammonium sulphate recovered makes it a profitable method of gas-making.

The writer believes that there is a great future before gaseous fuel, and that, ere long, it will to a large extent supersede solid fuel for many purposes with great advantage, both as to economy and efficiency, and that with this development the gas engine will to a large extent take the place of the steam engine as a source of energy.

BRITISH RAILWAY STOCKS AS DESIRABLE INVESTMENTS.

By William J. Stevens.

IN the ENGINEERING MAGAZINE for May last an able article appeared from the pen of Mr. Thomas F. Woodlock, entitled : "Are English Railroads Good Investments ?" The conclusion he arrives at is not favorable to this class of securities at all. But it appears to the present writer that he has based his adverse view of the merits of British railway stocks too rigidly on the set of figures which he produces, and which, on a cursory view, may seem to justify his apprehensions. The basis of Mr. Woodlock's criticism is revealed in the following quotation from the article referred to : "The first thing that strikes one on investigating the statistics of the railroads is that in the last few years they have absorbed a very large amount of capital, without a corresponding increase in mileage."

"The second thing—even more striking—is that this increase in capital has not produced a proportionate increase in net revenue. The third (necessary consequence of the preceding) is that the average return on British railroad capital shows a tendency to decrease. These are three very important facts bearing on the character of this capital as an investment."

The points indicated above are brought out carefully by the statistics contained in the article. But, while admitting that all the above contentions are true, they do not prove that there is anything inherently unsound in the position of British railways. The arguments which Mr. Woodlock so skilfully supports by his figures all turn on the important phrase in the above quotation from his article—"the last few years." It would be nothing less than madness to attempt to prove that the position of the railways of the United Kingdom has not very seriously deteriorated within the last few years. Gross revenue has certainly increased, but expenses have increased more rapidly, and dividends have fallen "in the last few years;" yet the real position of the railways is good. Railways, like every other branch of industry, are liable to fluctuations in their fortunes, and these fluctuations follow very closely the course of trade in the United Kingdom. When trade is good, traffic is good, net revenue increases, and the net return on the capital increases. When trade is bad, traffic does not increase to the same extent (in fact, does not increase at all, but really declines, if allowance be made for the increased mileage), expenses do not decline in any appreciable proportion, and dividends consequently suffer. But such changes are entirely beyond the management of the railways, and are the outcome of extraneous influences, by which it is hardly just to acquit or condemn them *qua* railways. Because they suffer from the inevitable fluctuations in trade, does it follow that their merits as investments are to be gaged thereby? If the trade of any country were steadily declining without hope of recovery, that would, of course, render the railway stocks undesirable investments; but in that respect they would suffer only in common with all industrial securities.

Fortunately, during the last twelve months, the trade of the United Kingdom has taken a distinct turn for the better, and the railways are showing large increases in their traffic. For the second half of 1895 they showed important increases in their dividends, which improvement, according to previous experience, may be expected to continue for the next few years. Mr. Woodlock's figures, be it remembered, showed the position only to the end of 1894, that being the latest period for which the board of trade statistics relating to the railways of the United Kingdom are as yet available. It is unfortunate that he did not examine the results of British railways since the end of 1894. It may be well to recall the fact that both 1893 and 1894 were exceptionally bad years, on account of coal strikes without parallel in the industrial history of the United Kingdom. In the second half of 1893 a great strike took place in the Midlands, mainly as a result of which five important companies alone lost £1,738,000 (say, $8,690,000), nearly all of which was net loss, owing to inability to reduce expenses, the price of coal being very high. In the following year, from July to October, a strike occurred among the coal miners of Scotland, which, though not so serious as the English strike of 1893, nevertheless played havoc with the gross earnings of the Scotch railways. Bearing these facts in mind, can it be matter for surprise that the net return on the capital of British railways in 1893 and 1894 was, with one or two exceptions, the lowest in their history? And it is on the results of the later of these two years that Mr. Woodlock has based his adverse judgment of British railways as investments!

From 1885 to 1889, as Mr. Woodlock showed, the average return on the whole capital of British railways increased from 4.13 per cent. to 4.32 per cent., while the average dividend on the ordinary capital increased from 4.04 per cent. to 4.66 per cent. That was a time of improving trade, and presumably, if Mr. Woodlock had applied his test of the merits of these stocks in 1890 or 1891, instead of in 1896, he would have come to a favorable conclusion. From 1889 to 1894 the average return on the whole capital declined from 4.32 per cent. to 3.87 per cent., and the average dividend on the ordinary stocks from 4.66 per cent. to 3.80 per cent. That was the outcome of a period of declining trade, with two years of unprecedentedly disastrous strikes at the end of it.

What has happened since in 1894? Well, for the first half of 1895 trade did not show any improvement, while passenger traffic was injuriously affected by a very severe and prolonged frost. But in the second half of 1895 traffic showed an all-round improvement, expenses did not show a relative increase, and the net receipts improved to such an extent as to enable the majority of companies to pay considerably increased dividends, as compared with the second half of 1894. Subjoined is a comparison of the distributions for the second half years of 1894 and 1895 as regards the twelve principal English and Scotch railways, to show how general, and in some cases how large, the improvement in dividends was:

Company.	Dividend. per cent. per annum. 2nd half, 1894.	Dividend. per cent. per annum. 2nd half, 1895.	Increase.
Caledonian	3¼	5½	2¼
Great Eastern	2¼	4	1¾
Great Northern	4	4¾	¾
Great Western	6	7	1
Lancashire & Yorkshire	4½	5¼	¾
London & No. Western	6¾	7½	¾
London & So. Western	7½	7¾	¼
Manchester, Sheffield & Lincoln	1½	1¾	¼
Midland	5¾	6¼	½
North Eastern	6¾	6¾	—
North British { Preferred	1½	3	1½
North British { Deferred	nil.	1¼	1¼
South Eastern	5¾	6	¼

During the current year the improvement in gross traffic has continued, and there is every promise of further improvement in the dividends. The *Railway Times* records the increase of the thirty-three principal railways for the twenty-two weeks to the end of May as £2,322,000 (say, $11,610,000), representing an increase over the 1894 figures of nearly 8 per cent., though the addition to the mileage was less than three-fourths of one per cent.

There is every reason to hope that a large proportion of the increase in gross receipts recently recorded will be retained as an addition to the net revenue, and that a material increase in dividends will take place during the current year. The general experience in the second half of last year warrants this belief, while the improvement will have all the greater effect on dividends, as the capital expenditure has lately been on a much diminished scale. The effect of all this will be, of course, to materially improve the average return on the whole capital of the railways of the United Kingdom, which, as Mr. Woodlock showed, had fallen in 1894 to only 3.87 per cent. compared with 4.13 per cent. in 1885.

One important point should be called attention to,—the effect of merely nominal additions to capital in increasing the apparent capitalization per mile, and also in reducing the apparent net yield on the whole capital. From 1885 to 1894 the total capital of the railways of the United Kingdom increased from £815,858,000 (say, $4,079,-290,000) to £985,387,000 (say, $4,926,935,000). But in the latter figure is included £81,044,000 (say, $405,220,000) representing these nominal additions. A very large proportion of this nominal increase arose in the ten years 1885-1894. Mr. Woodlock himself puts it at $450,000,000 (page 241, vol. xi). This is obviously an overstatement of the case ; I think $300,000,000 would be nearer the mark.

Observe the effect of this. If nominal additions be included, as they are in Mr. Woodlock's figures, the amount of capital per mile of railway is shown to have increased from $212,605 in 1885 to $235,650 in 1894. If the proper course of excluding the nominal additions be followed, then the amount of capital per mile is shown to have increased by only $8,745,—to $221,350 per mile. Similarly the net return on the capital is calculated in 1894 on the sum thus swollen by nominal creations of capital, and on this basis the apparent decline in the net yield was from 4.13 per cent. for the year 1885 to 3.87 per cent. for 1894, whereas, if due allowance be made for the "watering" of the capital in the interval, the return for the year 1894 would really be over 4 per cent.

The increase in the mileage between 1885 and 1894 was only 1,739. But in 1885, out of a total mileage of 19,169, only 10,446 were of "double or more lines," as against 11,392 in 1894, out of a total mileage of 20,908. Thirteen leading companies which, as recently as 1888, had among them 138 miles with three lines and 351 miles with four or more lines, had in 1894 increased their three-lines track to 146 miles and their four-or-more-lines-track to 504. These are developments of their existing systems which entail large outlays of capital, and which add immensely to their facilities for handling traffic ; but they are not disclosed in the mere statement of their longitudinal mileage.

There is another important consideration bearing on the question of the net return on the capital invested in British railways. To maintain their ordinary dividends at the rates then paid, it is not necessary for them to maintain the same overhead return on their whole capital now as ten years ago, or even five years ago. The rates at which they have been able to raise new capital have constantly been falling, and in a most marked way has this been the case since 1889. The average cost to the leading railways of the money they have raised since 1889 does not appreciably exceed 3¼ per cent., and at the present time is under 3 per cent., while ten or twelve years ago the average cost of new capital would have been about 4 per cent. Since 1889 the railways have raised, in all, about one hundred million pounds sterling, and the difference between 3½ and 4 per cent. on this sum amounts to the very important figure of £750,000 (say, $3,750,000) per annum. This sum represents nearly one-tenth of one per cent. on the total capital outstanding.

If the results had been brought up to the end of 1895, and then a comparison made with 1885, the position of the British railways would have looked much more cheerful, as the following table showing the dividends paid on the principal ordinary stocks for 1885 and for 1895 evidences :

Stock.	Dividend p. c. for 1885.	Dividend p. c. for 1895.	Increase or decrease.
Caledonian	4	5	— 1
Great Eastern	2	2⅜	— ⅜
Great Northern	4½	3⅝	— ⅞
Great Western	5	5⅛	— ⅛
Lancashire & Yorkshire	3¼	4½	— 1¼
London & North Western	6½	6⅜	— ⅛
London & South Western	5	6⅛	— 1⅛
London, Brighton & So. Coast	4⅜	6	— 1⅝
Midland	5⅛	5⅛	—
North British	2½	3⅝	— 1⅛
North Eastern	6	5⅝	— ⅜
South Eastern	4⅝	4⅛	— ½

There is no evidence in the above table of any general deterioration in the position of British railways, for the increases largely outweigh the decreases. Where the latter are shown, it should further be noted that the increase in gross receipts already recorded for 1896 leaves no room for doubt that they will pay higher dividends for the current year than for 1885, which, by the way, must be admitted to have been anything but a good year.

But the improvement in the rates of distribution on the ordinary stocks in the second half of last year, and the continued increase in gross receipts since, are very reasonably regarded as only the beginning of a period of reviving dividends, following as previously a period of declining dividends. Owing to the coal strikes in 1893 and 1894, to which reference has been made, the period of falling profits has been prolonged for nearly six years,—namely, from 1889 to the middle of 1895.

One most encouraging point about British railways is that they have, during the past five or six years of declining trade, met and overcome an exceptional increase in certain items of working expenditure. The principal of these items have been "wages" and "rates and taxes." Both have, from various causes, increased rapidly during the last ten years. Now the increase has been arrested, so that increasing gross receipts will not be eaten up, as in the past, by increased expenses, but will have due effect on net receipts and consequently on dividends. Mr. Woodlock in his article finds fault with the companies because, since 1889, nearly the whole increase in expenses has been in what he terms the "compulsory" expenses, while the expenses connected with the maintenance of permanent way and rolling stock, described as "optional" expenditure, have increased only very slightly. From this he draws the conclusion that "the railroads seem to have been compelled to spend so much more money to run their trains that they economized on the repairs and maintenance of their property." This is a serious charge; the more so because Mr. Woodlock goes on to draw the inference that capital is being made to bear the burden of this false economy in revenue charges for maintenance. But what are the grounds for the charge? Of a very negative character indeed, when examined closely. Compared with 1885, the maintenance charges showed a reduction of 0.5 of a cent, and, compared with 1889, an increase of 0.3 of a cent, per train mile, in 1894. The lessened cost of materials would alone justify the decrease, while it is a rule, even among the best companies, to be more liberal in their maintenance expenditure in good years than in poor ones. The average cost of rails in Great Britain fell over $2½ per ton between 1889 and 1894. As for the increase in other expenses,—*i. e.*, "compulsory" charges which in 1889 and 1894 amounted, according to Mr. Woodlock, to 3.5 cents per train mile, of which 1.5 cents was in motive power and 2.0 cents in "other" expenses,—the explanations are provided by himself. They are the increased cost of labor, the higher price of coal (the latter included in motive power), and, we may add, the addition to rates and taxes. The principal increase in wages was in the traffic department, included in "other" expenses. The large addition to the sum thus expended accounts for a good deal of the additional expenditure per train mile, and, though wages in the maintenance departments have increased relatively quite as much as train mileage, they do not represent the same important addition to the rate per train mile as in traffic expenses, for the reason explained below. This will be illustrated by the following, showing the wages paid in the "maintenance" departments of the four leading lines in 1889 and 1895, and the corresponding sums paid as wages in the traffic department:

WAGES INCLUDED IN MAINTENANCE OF WAY; LOCOMOTIVE, CARRIAGE, AND WAGON REPAIRS.

Company.	1889.	1895.	Increase.	Per cent.
	£	£	£	
Great Western	1,016,216	1,230,803	214,587	21.1
London & No. Western	1,155,116	1,286,752	131,636	11.4
Midland	1,091,298	1,299,162	207,864	19.0
North Eastern	957,059	1,089,959	132,900	13.9
Total £	4,219,689	4,906,676	686,987	16.3

WAGES IN TRAFFIC DEPARTMENT.

Company.	1889.	1895.	Increase.	Per cent.
Great Western	858,861	1,012,640	153,779	17.9
London & No. Western	1,481,760	1,722,226	240,466	16.2
Midland	1,223,210	1,622,440	399,230	32.6
North Eastern	765,186	1,020,543	255,357	33.4
Total £	4,329,017	5,377,849	1,048,832	24.2

It will thus be seen that wages in the "maintenance" departments have increased by 16 per cent. In the traffic department they have increased by £1,048,800 (say, $5,244,000), or 24.2 per cent. since 1889. The reason for the discrepancy is this. During recent years there has been a strong movement in the direction of shorter hours, and there has been legislation since 1889 to compel this in certain circumstances. This has affected the out-door staff, such as signalmen, guards, porters, shunters, etc., to a considerably larger extent than the men—most of them skilled artisans—employed in the repairing-shops, who already had regular hours, with payment for overtime; and the increase in the wages paid in the maintenance departments represents little more than the increase in work done. The whole burden of increased rates and taxes, moreover, has been included in the increase in "other" expenses referred to. Between 1889 and 1894 the increase over all the lines averaged well over 25 per cent., the addition alone amounting to nearly £600,000 (say, $3,000,000). The cost of coal rose as well, and, as both these items are included in the "compulsory" expenses, while having no counterpart in the maintenance or "optional" charges, is it at all strange, after all, that the latter have not increased so fast as the general expenses of railway working?

That the railways of Great Britain have withstood so well the period of comparatively stationary gross receipts, increasing expenses, and new capital burdens is the best possible evidence of their financial stability. Now that the prospect has changed and the revenue of the railways is increasing, they are likely to get something like an adequate return on the capital outlay incurred during recent adverse years. This capital outlay has fully prepared them for the efficient handling of a much larger traffic than that of late years, and there can be no doubt that a very large share of the increased receipts will go to improve dividends. New capital burdens are not so large this year as they have been for a long time,—a point which is of the utmost significance at the present juncture.

What wonder that with the vista of a period of improving dividends which has opened up after about six years of declining distributions, investors have made a run on the ordinary stocks of British railways with the result that prices have, during the present year, very materially improved? The high prices of all investment securities of a good class had already, in recent years, maintained the ordinary stocks at prices on which the yield, on basis of the declining dividends, has been only 3 to 3½, and, in the instance of some of the more speculative stocks, the return was even less than the former of these rates. The great dearth of investments which offer to the British investor any prospect of improving results, without unreasonable risks, has no doubt served to accentuate the demand for railway stocks. The constantly diminishing yield on the "gilt-edged" securities also is a strong incentive to the purchase of the ordinary stocks of railways, which offer, in compensation for the additional risk, a substantially larger yield.

In spite of the very large advance in the quotations of the ordinary stocks, the concurrent improvement in the gross receipts has been so great that the average yield, based on a conservative estimate of the dividends for the year ending June 30, 1896, is fully 3⅜ per cent. Nearly a dozen important stocks yield more than the latter rate. This yield represents, too, only the probable outcome of the improvement in gross revenue already in hand, and takes no account of the very probable further improvement in dividends in the second half of 1896.

This yield, even allowing that prospects are good, is undeniably a low one for a railway ordinary stock, and, without doubt, implies a large measure of confidence on the part of those investors who are prepared to take these stocks with only this small return. And that confidence has hitherto been well merited, while, as regards the smallness of the yield, the capitalist who patronizes these stocks is apt to say to anyone who criticises his judgment: "Show me where I can do better elsewhere." The long period of cheap money has added a string of difficulties for the capitalist to meet as best he may.

The yield on Consols in 1885 was very nearly 3 per cent., for, while carrying that rate then, they were not throughout the year quoted higher than 101½. At the present time they bear interest at the rate of 2¾ per cent., which rate continues until 1903, when they become automatically only a 2½ per cent. security redeemable at par in 1923. They are now quoted at over 113, and the true yield at the present time is, therefore, considerably under 2 per cent. Corporation stocks yield little more than 2½ per cent.; some yield even less. British railway debenture stocks of good lines yield only about the same rate. The Great Western company actually succeeded in placing a 2½ per cent. debenture stock issue at 104½ recently! This is the first issue of a stock of that denomination by an English railway. The best preference stocks yield barely 2⅝ per cent. In 1885 the 4 per cent. debenture stocks of the North Western and Midland Companies stood at 123 to 125. Now the 3 per cent. stocks into which they have been converted stand at the same figure, the yield having thus declined four-fifths of one per cent. In the light of these facts is it, after all, so extraordinary that the ordinary stock of the North Western Company, which in 1885 received 6½ per cent. dividend and was not then quoted higher than 171, should at the present time stand at 200, with a dividend on the present results of 6¾ to 7 per cent., or that Midland Railway ordinary stock, which in 1885 received a dividend of 5⅛ per cent. and did not command more than 135, should now stand at 168 with a current dividend of about 5½ per cent.?

As regards the confidence reposed by British investors in the railways of the United Kingdom as channels for investment, is there not ample justification for it? They are ably and, above all, honestly managed. Those concerned in the actual conduct and management of the traffic of British railways are not concerned directly in the financial administration; therein lies their strength. The evils of the dual control—the same persons having control of the management and the finances of the railway—are well set forth by the results of American railways, and it is undoubtedly one of the weakest points about the latter from the British investor's point of view.

English railway accounts are not perfect, but they are honest and straightforward, as a rule. They are audited half-yearly, and the official figures have to be filed with the board of trade. Above all, there is no manipulation of figures for market purposes, either as regards the half-yearly accounts or the traffic publications. In his article on "The Fruits of Fraudulent Railroad Management" in the June issue of the ENGINEERING MAGAZINE Mr. J. Selwin Tait, rightly says: "The principal source of distrust in American railways . . . . is the manipulation of accounts." English railways have to make up their half-yearly accounts in a form specially designed for them, as enacted by the Regulation of Railways Act of 1868, which applied to all railways then in existence and has been incorporated in all special acts since. British railways, it may here be pointed out, hold their right of existence direct from imperial parliament through special acts passed in the case of each undertaking. In addition, there are numerous enactments relating to railways only which regulate their conduct, unless the provisions of the general acts are specifically varied by the special act of an individual company. The advantage of the special act in the case of each company is that parliament, having granted certain privileges on the terms of which the capital for the lines was provided, must always recognize its obligation to protect the railways from confiscatory measures.

A feature about British railway stocks is that, unlike the majority of American common stocks, they represent actual cash payments, sometimes of considerably more than their par value; North Western ordinary stock, for example, has had over £115 paid in cash to the company for every nominal £100 in existence.

Though in several respects capable of improvement, the railways of the United Kingdom are, on the whole, sound undertakings, ably administered and financially strong. Nothing probably has more strengthened the confidence of investors in British railway securities during the last four years than the contrast they have presented with American lines, for it is precisely those evils which, in the case of the railways of the United States, have been so woefully exemplified during late years that are most alien to the constitution of the railways of the United Kingdom. The railways of both countries have come through a period of exceptional adversity,—surely one of the truest tests of stability,—but how differently! A large proportion of American roads are still in the hands of receivers, and the fixed charges of many others have had to be cut down. On the other hand, the credit of British railways is now better than ever before, and all have come through the trying times unscathed and in a position to benefit fully from the trade improvement now in force. There is thus every reason to regard the stocks of British railways as thoroughly good investments.

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Am. Engineer and Railroad Journal. *m.* $2. N.Y.
American Gas Light Journal. *w.* $3. New York.
American Geologist. *m.* $3.50. Minneapolis.
American Journal of Science. *m.* $6. New Haven.
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American Miller. *m.* $2. Chicago.
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Am. Soc. of Irrigation Engineers. *qr.* $4. Denver.
Am. Soc. of Mechanical Engineers. *m.* New York.
Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
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Architectural Review. *s-q.* $5. Boston.
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Bankers' Magazine. *m.* 18*s.* London.
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Brick Builder, The *m.* $2.50. Boston.
British Architect, The. *w.* 23*s.* 8*d.* London.
Builder, The. *w.* 26*s.* London.
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Bulletin Am. Iron and Steel Asso. *w.* $4. Phila.
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California Architect. *m.* $3. San Francisco.
Canadian Architect. *m.* $2. Toronto.
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Electrical Plant. *m.* 6*s*. London.
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Electrical Review. *w.* $3. New York.
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Journal Assoc. Eng. Society. *m.* $3. St. Louis.
Journal of Electricity, The *m.* $1. San Francisco.
Journal Franklin Institute. *m.* $5. Phila
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q.* $2. New London.
Journal Political Economy. *q.* $3. Chicago.
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Journal of the Society of Arts. *w.* London.
Journal of the Western Society of Engineers. *b-m.* $2. Chicago.
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Lord's Magazine. *m.* $1. Boston.
Machinery *m.* $1. New York.
Machinery. *m.* 9*s*. London.
Manufacturer and Builder. *m.* $1.50. New York.
Manufacturer's Record. *w.* $4. Baltimore.
Marine Engineer. *m.* 7*s*. 6*d*. London.
Master Steam Fitter. *m.* $1. Chicago.
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Stone. *m.* $2. Chicago.
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago
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Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga. Tenn
Trans. Assn. Civil Engs. of Cornell Univ. Ithaca.
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Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* $10. New York
Transport. *w.* £1. 5*s*. London.
Western Electrician. *w.* $3. Chicago.
Western Mining World. *w.* $4. Butte, Mon.
Western Railway Club, Pro. Chicago.
Yale Scientific Monthly, The. *m.* $2.50 New Haven.

The Tenement House Competition.

THE wish to be just in ascribing honor to whom honor is due is common to all right-minded men. The recent award by the commission of the "Improved Housing Council" gives occasion to our esteemed contemporary, *The Engineering Record*, to assert its claims as a pioneer in this kind of competition. In 1879, while it bore the name of the *Sanitary Engineer*, this paper had much to say upon the subject of improved tenement houses, and said it well. Those familiar with the paper at that period will remember that it instituted a competition, in which architect James E. Ware was the successful competitor. This gentleman is also one of the successful competitors in the competition of the Improved Housing Council, the other successful ones being architects Ernest Flagg and A. W. Ross.

The *Sanitary Engineer* was, therefore, among the first publications in the United States to emphasize the need of improvement in tenement house architecture, to demonstrate the possibility of such improvement, and, through the design of Mr. Ward, to indicate the lines upon which such improvement should advance. This busy age moves so rapidly that the recollection of details of events is soon effaced by events which follow. Therefore in its issue of June 6 *The Engineering Record* very properly recalls the facts above stated, the principal difference of the recent competition from that of 1879 being that the conditions apply to the construction of an entire block, whereas the former competition applied to a single tenement building. Nearly all the conditions of the recent competition correspond with those of the single tenement building as set forth in the competition of 1879.

All apartments were required to be lighted by windows directly opening upon the outer air, and to have cross ventilation. Each compartment was required to have an independent fire-proof staircase inclosed by brick walls and having a separate entrance from the street. Each suite was required to have its separate water-closet opening directly to the outer air. Each living-room was to be accessible without passing through any other room, and entrance to each bed-room without passing through any other bed-room was to be provided. Living-rooms were to have one hundred and forty-four square feet of space, and bed-rooms seventy square feet. Height, six stories.

The features of the plans prepared respectively by the architects named, as published in the New York *Tribune*, are as follows:

"Mr. Flagg divided his block lengthwise by a passage about 30 feet in width. On each oblong rectangle he puts four square pavilions separated by courts 18 feet wide and 60 feet deep, opening from the street, leaving the wall line on the interior passage unbroken. Each pavilion has a court 30 feet square. The staircases, four to each pavilion, open on the corners of these courts, and are set diagonally, leaving all possible window space for the apartments. There is an open lift for every two apartments. Generally three suites open on each staircase at every floor. In the arrangement of rooms Mr. Flagg has a living-room, from which in most cases opens a kitchen with a sink. Then there are one or two bedrooms. This living-room is the passageway to the kitchen. The water-closets of the different suites are generally separated by some distance, thus requiring extra piping, and either opening directly from the living-room or on the pavilion courts, where they can be reached only through an open balcony. Mr. Flagg has secured excellent cross ventilation, as one or more rooms of each one of his suites open on the outer air, while others look on the pavilion court.

"Mr. James E. Ware goes even further than Mr. Flagg in arranging for air currents through the block. He divides it transversely by two narrow alleys about 100 feet from each avenue, and connects these alleys by a third alley down the middle of the block, so the three passages form a letter H and divide the block into four equal parts about 100×200 feet, each with a long side or street or avenue. On each plot are built two pavilions, cut nearly in two by a deep court, with a court 30 feet square in the middle of each pavilion, similar to the plan of Mr. Flagg, except that these square courts are all connected with the outer air by one and, in some cases, two slits, from the ground up, thus making the building outline of two pavilions resemble that of a rectangular figure 3. The main entrances are through arches into the pavilion courts, and corner staircases give access to three or four apartments on each floor, somewhat as in Mr. Flagg's designs. The water-closets all open on private halls, and are exceptionally well arranged for tenants. The number of apartments in this design is the same as in Mr. Flagg's, but the rooms are small. Mr. Ware gives the maximum of draft between the parts of his building, but both he and Mr. Flagg have many apartments that look out on the interior alleys.

"Mr. A. W. Ross gives every suite an outlook on the street, and at the same time on an interior court. Like the other two architects, his building is about 30 feet deep between exterior walls; but, instead of arranging his floor space about small courts, he connects it all about a great central court, getting open wall space by turning his walls in and out like a Greek fret. That is, the hollow square of a building is deeply indented by courts 30 feet wide from the street alternately with narrower courts from the long, alley-like court through the middle of the block. There is a staircase for every pair of apartments, and they are partly internal and partly external. Cross-ventilation for corner suites is secured by turning a special external half-staircase from the main stairways, situated at the ends of the interior courts. These steps go only to the single apartments, and the door opening on the air makes a draft from the rooms outside to the court possible without surrender of privacy. Comparatively few of the apartments look directly on the street, but there is not one from the windows of which a view down the broad court to the street may not be had. Those nearest the street look out almost directly, but even far back in the court the angle is not more than 45 degrees.

"The living-rooms in the plan of Mr. Ross are generally large and well arranged. The living-rooms all open to the front, as well as some of the bedrooms, while the water-closets are on the courts and are entered from private halls. There is an interior lift for each two apartments."

Competitions in Design.

WAS there ever a competition between artists without an exhibition of jealousy unworthy of those who display it? Was there ever a beautiful woman that would acknowledge the existence of equal beauty in a rival? Whenever a prize competition is instituted, the apple of discord is thrown.

Not to speak of recent examples of reciprocal jealousy among sculptors, painters, actors, and musicians, the competition mentioned in the previous article has again shown that even architects of reputation and ability are not above this weakness.

Not content with being among the three honored with awards, out of twenty-eight competitors, it is said (New York *Sun*, June 10) that Mr. Flagg charges plagiarism against Mr. Ware, who won the first prize in the competition of 1879. The specific charge is that Mr. Ware has copied features of a design prepared by him and illustrated in *Scribner's Magazine* some two years ago. As these features were, according to the reply of Mr. Ware, embodied in a building erected by the latter four years ago, it seems that the charge of plagiarism must return upon Mr. Flagg, although Mr. Ware is magnanimous enough not to make such a charge, and justly recognizes that, under a set of rigid conditions, like those to which the architects were confined, it is not unlikely that some features in each plan would be like those in some of the others, or in previous plans. Resemblances thus originated are not necessarily plagiaristic, since they might correspond with something the designer had never seen, and be virtually original with himself; or, though previously known, they might be compelled by the conditions.

It is unfortunate that such squabbles should result so often from competitive work; they are extremely tiresome to the general public.

The English Brickwork Tests.

THE Royal Institute of British Architects has, through a committee, been carrying on a series of experiments to ascertain the ultimate crushing load of brickwork columns, so that the relative strength of such may be compared with the resistance possessed by the individual bricks of which they are composed. The results of the first series of experiments were recently laid before the Institute, and are admirably summarized in *The Builder*. A full account of the experiments is given in the *Journal of the Royal Institution of British Architects* (April 2).

A table of average results shows that the strength of brickwork is not so great as it has been assumed to be. The piers tested were erected five month's prior to the tests, and a further series of experiments is to be made on piers after ten months, which may show greater strength. The utmost care was taken in the construction, though the effort was to produce piers which would represent everyday construction, rather than those built under exceptional conditions. An hydraulic apparatus exerting a pressure in excess of five hundred tons was employed in the experiments.

The tests developed a remarkable difference between the crushing of separate bricks and of piers composed of the same sort. A pier of Leicester red bricks was crushed with from 29.93 to 67.36 tons, while single bricks sustained 311.4 tons to 591.4 tons. That the difference was not caused by the pointing was shown by a number of photographs, in which the tendency to crack in the center was distinctly visible. Some failures, however, were shown on the lines of vertical juncture, and it may be questioned if we use the best method of bonding for resisting pressure. It was further shown that half bricks crush at a lower pressure than whole ones, the difference, in some grades of brick, being as much as one-half.

A Stand-Pipe Plumbing System.

AN example of the plumbing system herein presented has been erected in the College of Physicians and Surgeons in New York city. The description of it is condensed from *The Engineering Record* (June 15).

"Instead of pumping all the water used into an elevated tank and distributing it thence to the different lines in the house, the water is pumped into a comparatively small stand-pipe that does not serve in any considerable way to provide storage, but rather acts as a pressure regulator for the pump to act directly against and maintain the supply and head of the water used in exact accordance with the amount used, thus promoting simplicity and directness, and virtually applying to a domestic installation the system long ago adopted for municipal water-works and known as the Holly system. The water is received through meters from two street mains into an open suction tank in one corner of the engine-room, which has sufficient storage capacity to provide for an even pump action, is filled through ordinary ball cocks, and is covered by a light-hinged iron plate and manhole. From this tank the water is pumped through an 8-inch suction line into the foot of a vertical column of 12-inch pipe, about 120 feet high, and from the 6 inch pump discharge which is connected to this stand-pipe the different lines to distribute the water throughout the building are branched. Each of them is thus in free communication with the stand-pipe, and receives from it pressure due to the head of water in it, equivalent to being connected with an elevated tank as high as the level of water in the stand-pipe, and avoiding the necessity of providing a support for several tons of water in the top of the building. The corresponding requirement is that water should be constantly pumped into the system as fast as it may be drawn out, so as to maintain a regular pressure. This is easily provided for by requirements of the fire protection system, which would close the valves, V V, and, shutting off the steam, stop the pumps when the head of water in the stand-pipe rises above the required level, and open them and start the pumps when the water falls below this level. These regulators, R R, are of the ordinary kind, having a piston on the

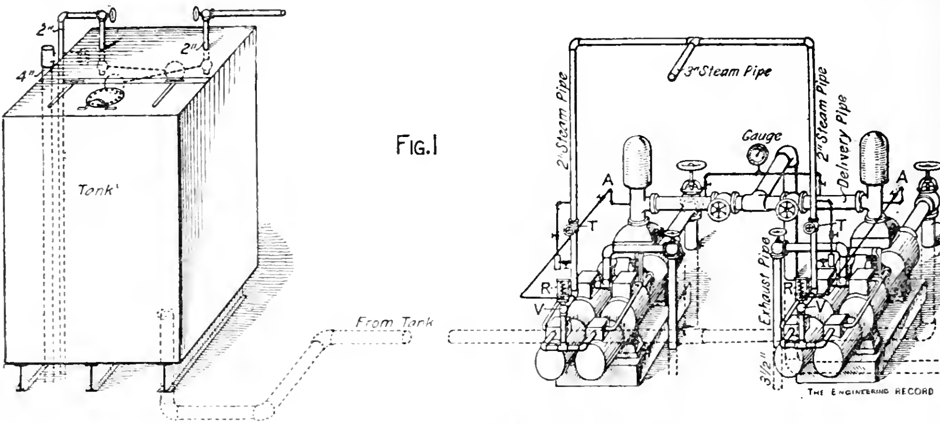


FIG. 1

A STAND-PIPE PLUMBING SYSTEM.

have been installed independently of this feature in any event."

Two Snow duplex pumps (Fig. 1) "have their supply and discharge mains laid in floor conduits which are accessible through checquered cast floor plates of a convenient size, and the steam supplies are governed, inside the throttle valves, V V, which are ordinarily left open. They may be operated at will by hand by Ford's patent regulators, R R, that automatically

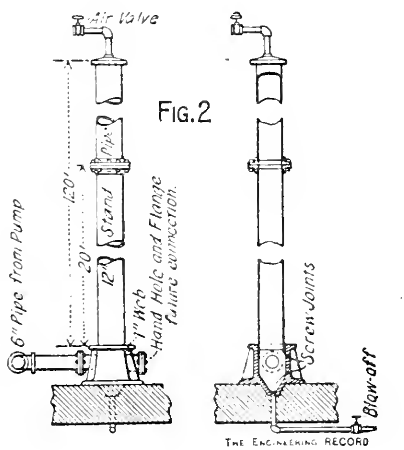


FIG. 2

upper end of the produced stem of the valve, V, and a spiral spring attached to the stem above the piston in such a manner as to open the valve until the pressure in the stand-pipe becomes too high. The regulator piston works in a small cylinder, which is in free communication, through the open pipe, A, with the pump discharge, and, when the pressure there becomes too high, it overcomes the effect of the spring, and the piston moves in the cylinder against the spring and closes the valve, V. The gage is connected very close to the air chambers on the discharge pipe in such a manner that, if the pump was accidentally started with its discharge valve closed, the gage would instantly indicate it by violent fluctuations."

The stand-pipe is made of six 20-foot lengths of $\frac{5}{16}$-inch galvanized wrought-iron pipe 12 inches in diameter, screwed into flange collars bolted together. The base of the stand-pipe is a casting shown in Fig. 2, supported on a masonry pier. The conical section of the casting facilitates blowing out sediment. "The top of the stand-pipe is closed and provided with a safety overflow pipe and valve. Normally the valve is open, but it may be closed to permit the maintenance of a high pressure for fire or other purposes; greater than can be secured from the head due to height of the pipe alone. Practically it is found sufficient to keep the stand-pipe filled with water up to about 20 feet below the top." This is a well-designed system, with details carefully worked out, and, although unusual, we see no reason to suspect it of inefficiency or inconvenience.

Pest-House Architecture.

An example of a design for a hospital for infectious diseases, by Messrs. Speirs and Co., a firm of Glasgow architects, affords a pleasing contrast to many of the buildings used by American cities for the purpose of isolating infected patients, and which are "pest-houses," not only in the sense that they are used for the treatment of pestilential diseases, but also in the sense that in appearance they are offensive to taste, and in their facilities for proper care of the unfortunates confined in them a disgrace to civilization. The firm of architects named has become noted for hospital construction, and this hospital has been built on a patented system which the firm has applied in a large number of similar buildings in Scotland.

We herewith reproduce from *The Sanitary Record* (May 29) an engraving of the building referred to, which has been erected at Newton Stewart.

It consists of three blocks, having wood weather-board walls and iron-sheeted roofs. The interior is lined with special tongued and grooved stored lining, all neatly stained and varnished, and presents a most comfortable appearance. The space between the outside and inside covering is divided into two spaces by non-conducting sheathing material, thus forming air-cushions, and absolutely ensuring that the building is impervious to either heat or cold. The hospital consists of two fever pavilions, each divided into two wards, with accommodation for sixteen beds in all. Between the two wards in each pavilion there is a nurses' duty-room with observation windows overlooking each ward, and to each ward there is separate lavatory and bath-room accommodation. Between the two fever blocks, and connected to same by open corridors, there is the administration block with doctor's and matron's room, kitchen, scullery, pantry, linen-store, coal-house, heating-chamber, and two small isolation or private wards. A short distance from the main buildings is placed the outhouses block, comprising ambulance shed, disinfecting-room, mortuary, wash-house, and laundry. The buildings throughout are fully equipped with the latest sanitary and other hospital

INFECTIOUS DISEASES HOSPITAL AT NEWTON STEWART.

appliances. The heating of the wards is obtained by low-pressure hot-water system, and a hot-water-supply is carried from the administration block to all the sinks, bathrooms, etc., of the wards.

Without describing the particular features of the patented system, *The Sanitary Record* commends it, and says that the local government board thoroughly approves it.

The Impending Doom of High Building.

THE high-building boom, in the opinion of *Architecture and Building*, has had its day. Under the title, "Shipping and Transit Needs of New York," this journal editorially discusses a number of improvements which the recent enlargement of the city boundaries, and consequent increase of population in what have been hitherto suburban districts, will demand. As pertinent to the subject, it notes that the enormous centralization of business in and about Broadway, threatened by the erection of tall buildings, would greatly increase the difficulty of comfortable transportation, and will, in all probability, be restricted. In this department of our July number mention was made of the Pavey bill, which provides for such restriction, and of the action of the American Institute of Architects, in strong approval of the purposes of the proposed legislation. To this purpose the large majority of the general public will also say amen. The present attitude of the foremost architects and of public opinion toward the further extension of tall building is well put in the editorial referred to, which, with reference to the pending bill, says:

"That such legislation is more than probable may be inferred from the efforts already made in this direction and the discussions going on in architectural and building circles. Many of our readers will remember the report of the discussion on the Pavey bill, where some of the very architects who had been the largest designers of such buildings strongly advocated restricting their height. In other cities such laws have been passed. Boston has the matter under consideration, as has St. Louis; and Chicago—the birthplace of the skeleton structure—has already passed a law to this effect. Under the influence of such a law the effect would be to so extend the area of the business portion of the city as to crowd, especially in the lower part of it, on to territory at present occupied by warehouses and manufacturing establishments and drive them in turn into the tenement districts, resulting in a larger patronage of marginal roads; so that a far-sighted view of the city's needs in this matter must take into account changes such as the one referred to. Besides, it would be no difficult matter to provide crosstown roads on depot streets, which would make these roads quickly and easily accessible."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Architecture and Building and Allied Subjects in the American and English Architectural and Engineering Journals—See Introductory.

*6508. The Architecture of Home-Making. Ill. Charles E. Benton (A discussion of the effect of home architecture on the home and the family). Eng Mag–July. 3500 w.

6559. The American Surety Building. (Illustrated description of foundation piers, column footings, cantilever girders and anchorages). Eng Rec–June 13. 1000 w.

*6572. Rocks and Building Stone. Dr. A. P. Coleman (From the report of the Ontario Bureau of Mines, 1893. Considers rocks from the geologists as well as the architects point of view, and gives description and analysis of the kinds most used for building, and the tests that should be made to determine the strength and durability). Stone–June. 1600 w.

†6576. Baroda Palace: the Town Residence of H. H. Sir Syaji Rao, G. C. S. I., Maharaja Sahib Gaekwar. Robert Fellowes Chisholm, with Discussion (Description of a palace in India, probably the most costly structure erected by a private individual during the present century). Jour Roy Inst of Brit Archs–May 21. 10000 w.

*6580. Old London Churches (Editorial review, with illustrations, of a book by George H. Birch). Builder–June 6. 3700 w.

*6587. "The Old Paths, Where Is the Good Way?" (Comparing some old things with some new, viewed from an architectural standpoint, to try to find out "the good way" in the past, then proceeding to describe those points wherein the men of the present have undoubtedly improved "the old paths"). Arch, Lond–June 5. Serial. 1st part. 2200 w.

†6658. Romanesque Architecture. Grant C.

Miller (A study of this style of architecture from the tenth century with illustrations). Tech-May, '96. 4800 w.

†6668. The Construction of Sky-Scrapers. C. T. Purdy (The knowledge required for success in structural iron work, especially house building; the importance of accuracy, and of safe foundations). Trans Assn of Civ Engs of Cornell Univ-June, '96. 6400 w.

6712. An Iron Synagogue Roof and Dome (Illustrated brief description of the new Temple Shaare Emeth in course of construction in St. Louis, Mo). Eng Rec-June 20. 500 w.

*6717. A Restaurant de Luxe (Illustrated description of an elegantly appointed establishment opened in the Prince's Hall, Piccadilly). Arch, Lond-June 12. 800 w.

*6718. Greek v. Roman Construction (Extract from a pamphlet entitled "Prologmenos on the Function of Masonry in Modern Architectural Structures," by R. Guastavino, architect, New York). Arch, Lond-June 12. 1600 w.

6724. Architectural Competitions. John A. Fox (Read before the Boston Soc. of Archs. An introduction to a discussion followed by papers by R. D. Andrews, and H. Langford Warren, with reprint of the "Abstract in a Projected Tract on Competitions," published in this journal in Jan. 1876). Am Arch-June 20. 8500 w.

*6755. The Housing of the Poor (What is being done in London and in Dudley). Rev of Rev, Lond-June 15. 3500 w.

*6821. Spanish Brick and Tile Work. C. H. Blackall (Illustrated description of architectural work in this material, especially of the Moorish style). Br Builder-June. Serial. 1st part. 2500 w.

6822. Improved Tenements. George W. Da Cunha (A discussion of the general principles upon which tenements should be constructed). Am Arch-June 27. 2600 w.

6897. The Ashmont Engine-House, Boston, Mass. (Illustrated description). Eng Rec-July 4. 1100 w.

*6922. Modern Opera Houses and Theatres (Editorial review of a book by Edwin O. Sachs and Ernest A. E. Woodrow, with comments). Builder-June 27. 3000 w.

6937. Old Lombard and Venetian Villas. Vernon Lee in *Cosmopolis* (An account of travels with but slight reference to the architecture in this first part). Am Arch-July 4. Serial. 1st part. 3000 w.

Heating and Ventilation.

6534. Pressure Records from a Vacuum Steam Heating System (Data from records of observations of vacuum steam heating plant in a building exposing 28000 sq. ft. of surface to northerly winds). Eng News-June 11. 500 w.

†6661. Heating and Ventilation by the Hot Blast System. F. H. Green and T. Weinshenk (Experiments with plant at the High School building at Champaign, Ill., with illustrated description of the heating and ventilating apparatus). Tech-May, '96. 1400 w.

6678. Ventilation and Heating of School Buildings with Furnaces. J. L Bixby, Jr. (A practical essay profusely illustrated in which the subject is ably treated). Met Work-June 20. 2000 w.

*6692. German Heating. Ill. (An interesting exposition of the methods employed in heating German houses). Dom Engng-June. Serial. 1st part. 1500 w.

6693 Heating and Ventilation of the Fitchburg (Mass.) High School (Illustrated detailed description). Heat & Ven-June 15. 1800 w.

6694 English Water-Backs. Frederick Dye (Review of English Practice). Heat & Ven-June 15. 1800 w.

6707. The "Vacuum" System of Heating. C. C. Dennis (A comparison of the advantages possessed by two different methods of operation of the system). Ir Tr Rev-June 18. 2200 w.

6713. Heating of the Medical Baths at Bellevue Hospital, New York City (Illustrated description of apparatus recently erected in this institution). Eng Rec-June 20. 700 w.

6790. Plumbing in a New England Residence (Illustrated detailed description). Eng Rec-June 27. 1200 w.

6899 Hot-Water Heating in a Baltimore Building (Illustrated description with plans of the heating in Notre-Dame Institute). Eng Rec-July 4. 700 w.

Landscape Gardening.

6601. An Architectural Garden. Thomas Hastings (A description of the grounds and buildings of E. C. Benedict, on the site of the old Indian Harbor Hotel). Gar & For-June 17. 2200 w.

6819. The United States and the Palisades. Ill. (A statement and discussion of the grounds on which interposition of the National Government is asked for the preservation of the Palisades). So Arch-June. 1200 w.

6955. Privacy in Suburban Life (Editorial review of an article on "Suburban Homes" in *The Cosmopolitan* for June, by R. Clipston Sturgis, with criticism of the homes of Americans, and their lack of individuality, and the character of the grounds). Gar & For-July 8. 1500 w.

Plumbing and Gas Fitting.

6560. A Stand-Pipe Plumbing System (Illustrated description of a system of distribution involving a departure from ordinary methods, by providing an artificial pressure above the street mains). Eng Rec-June 13. 900 w.

*6690. Samples of Work (Illustrated description of notable exhibits at an exhibition held in connection with the sixth annual congress of plumbers in Dumfries, Scotland). Dom Engng-June. 350 w.

*6691. Sanitary Schools (Abstract of a report upon Boston schools, by a committee of experts. The article is well illustrated with engravings of model and defective plumbing and drainage, ventilation and heating work). Dom Engng-June. 1900 w.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

The New East River Bridge.

THE project for a new bridge across the East river is beginning to emerge from the silence and comparative indifference which have so long kept the enterprise in the background, and to assume the interest which attaches to it chiefly as a temporary alleviator of the discomforts of travel between New York and Brooklyn.

The limitation is affixed advisedly; problems of transit in the greater New York are too large and too intricate to be much affected by any partial solution. When relief is afforded in any one direction, it merely seems to attract the ultimate surplus from other overcrowded channels, with the result that the congestion is soon equally bad on the new route and the relief to the other almost inappreciable.

It is almost inexplicable that this particular work has been so long delayed and so patiently awaited. The original structure had to win converts to its engineering possibility and fight the battle with navigation interests; these contests once over, it might have been expected that additional structures would have followed rapidly where the need was so great. Many of the smaller western cities have facilities enormously greater in proportion to the traffic, secured in the face of much more strenuous opposition from those interested in river transportation.

A very small increase in convenience or accessibility is found, not only to direct travel to a particular bridge, but to increase materially the total amount of traffic. Cincinnati, with five bridges, is vastly better equipped than New York will be with its two great structures and all its ferries; yet two of the five are being enlarged, and a sixth is projected.

Tunnel schemes, which at one time seemed likely to rival bridges in popularity, have fallen back again. The uncertainties of construction are greater, or at least are so considered, and underground travel is not in favor with the public, partly on account of difficulties of ventilation, but chiefly, in all probability, on account of an undefined repugnance. Curiously, a more material objection, from the engineer's point of view, is developing in connection with the Thames tunnel. It is reported that the increasing draught requirements of modern vessels threaten to leave an insufficient depth over the top of the tunnel, and the structure is likely to become the very thing for the avoidance of which it was constructed,—an obstruction to navigation.

The East river bridge presents few new features of construction, except in matters of detail; that is, it will be a suspension bridge, generally similar to the Brooklyn bridge now existing, supported by four steel cables carried over skeleton steel towers. The New York approach will be on the blocks bounded by Clinton, Delancey, Norfolk, and Broome streets; the Brooklyn approach, at Fifth and Roebling streets.

The sites for the foundations of the two piers have been decided upon, says the *Railway Review*, and the boring is now going on. "Just beyond the head of Delancey street wharf four holes have been bored in the bed of the East river with diamond drills, and the results attained have given assurance that a solid gneiss rock lies at a depth of sixty-one feet below water on the New York side. In descending to the rock foundation to build the piers, the method to be employed will be the same as in the work on the Brooklyn bridge twenty-five years ago. Caissons will be constructed, probably of steel, instead of wood, as formerly, and these will be sunk by weights of masonry. In the chambers within the caissons, to which the water cannot penetrate, the workmen will clear the rock of all earth and prepare a foundation of cement and broken stone. The two towers of steel will rise 332 feet above the water. Each tower will rest on four legs standing on the four corners of each caisson. About

117 feet above the river there will be an arched space, through which the main roadway for cars and foot passengers will pass.

"There will be six railroad tracks, two for elevated railroad trains and four for electric and other surface cars. Above this roadway, it is proposed, broad footways will be constructed, and also a bicycle path. Upon the level of the railroad tracks and between the legs of the towers will be an arched space on each side of the large one, for use as carriage ways. The width of the new bridge will be 117 feet, or 37 more than the old one.

The span from tower to tower will measure 1,610 feet, 15 feet longer than the Brooklyn bridge. The cable will be about 18 inches in diameter, three inches greater than those now supporting the enormous traffic between the two cities. In each cable will be 5,149 wires, and every strand will be capable of carrying a load of 5,000 pounds."

The commissioners expect to have the work complete by the year 1900, which would be very quick time.

The estimated cost is $15,000,000.

Echoes of the Kiel Opening.

THE Baltic and North Sea canal, judging from a recent review in *Transport*, must be classed among the disappointments in recent large engineering construction.

Not even the extensive advertising which was given it by a magnificent and widely-heralded opening, and which is supposed to be so large a factor in success, has attracted a sufficient volume of traffic to defray more than a fraction of the expenses. "Since the official opening, less than eight thousand vessels have passed through, none of them being of very large tonnage, and the receipts did not exceed 605,000 marks." The annual expenses are stated to be about three million marks. The calculations of the managers were that the annual revenue would be 5,000,000 marks, based on a traffic of 7,500,000 tons.

Transport attributes the small use made of the canal to the indifference of vessel-owners generally to a minor saving in time. Delays in loading and unloading are so customary, and are regarded as so unavoidable a feature of water transportation, that a little shortening of the route offers no inducement, especially when canal tolls must be set over against it. It might reasonably be expected that education in better facilities would overcome this indifference, and it may still be argued that, like other new departures, the canal must have time to introduce and commend itself to patronage, and that it is not fair to measure its ultimate success by a portion of the first year; but a graver reason is suggested by the significant remark that none of the vessels passing through were of very large tonnage,—indeed, as later noted, the "average size of the vessels which take advantage of the canal is 110 tons." The natural expectation would be that large vessels, being generally run on the lines of closest economy, would be the very ones to which the gain in time would be important, and that they would be the first to avail themselves of its advantages, unless there were strong deterrent reasons.

A possible discouragement (and a very serious one) will at once suggest itself to all who remember the grandly melancholy spectacle of the official opening, when the warships of all nations were supposed to pass proudly through the new waterway, but instead vied with each other in emulating the example of the hippopotamus in the song of Noah's Ark.

It was broadly hinted then that the canal would have been a better canal if naval and engineering expert advice had been followed, instead of being overruled by imperial dictum. There is no royal road to canal construction, and this royal canal seems to have the one important defect that the vessels for which it was especially intended fear such difficulty in traversing it that they are deterred from making the attempt.

Transport offers the consolation that by means of the canal "the German naval forces can concentrate themselves either in one sea or the other in a very few hours"; so they may—providing that they do not, in making the attempt, concentrate themselves midway of the canal.

The Nicaragua Canal Termini.

A VERY interesting letter from Mr. Silvanus Miller, C. E., is printed by *Engineering News*, and is an especially valuable contribution to the canal discussion, because of Mr. Miller's familiarity with the subject and ample opportunity to study climatic conditions on the ground during a considerable period.

Incidentally some suggestive hints are given as to the comparative endurance of earthworks in tropical climates.

In the absence of the disintegrating action of frosts, and in the rapid growth of a protective cover of vegetation, Mr. Miller finds preservative conditions very largely offsetting the effect of the heavy tropical rainfall.

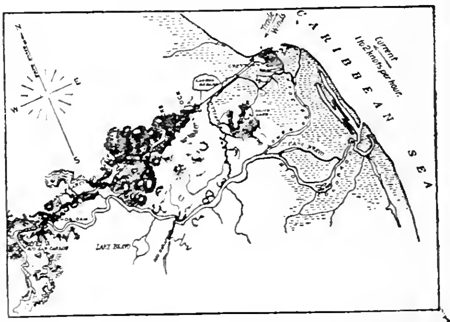
His statement that very steep slopes (from perpendicular to ½ to 1) stand better than flatter ones is more startling at first, but perfectly reasonable on a moment's reflection, the explanation being simply that much less surface is exposed to the rain.

The most important comment, however, is that made upon the proposed terminal harbors and their improvement,—points which were outside of the scope of the article in the June number of THE ENGINEERING MAGAZINE, and therefore were only alluded to therein. Mr. Miller's criticism is made clear by a map accompanying his letter, which is here reproduced with his remarks as follows:

"I still believe that the best method for making and maintaining a good port at Greytown would be by turning all the water of the San Juan river into the harbor once more. This, with a properly devised system of jetties, should be sufficient to scour out the harbor, and maintain it at a sufficient depth at all times. The accompanying sketch shows the general direction of the winds and currents at this point. All the sand that is now brought down by the Colorado branch is carried up the coast by the drift and deposited behind the point in front of Greytown, while, if this sand were brought down into Greytown harbor itself with the full current of the river, it would be carried out to sea and drifted on up the coast in the direction of Monkey river. I believe that this subject is well worth a careful study, and am not aware that proper attention has been directed to it.

"As long ago as 1888 I pointed out to Mr. Menocal the uselessness of the jetty as proposed by him to stop the drift of sand up the coast, and I now see from the report of the commission that exactly what I predicted has happened, as the sand has already filled in behind the jetty and is drifting around the end of it, and this will continue to happen, no matter to what length this jetty may be extended, although, of course, a jetty could be extended far enough to stop the drift for many years.

"With regard to the port on the Pacific coast, Brito is certainly a miserable little hole. A canal like this should have a port capable of holding a large number of vessels at one time, for various reasons.



Direction of Winds and Currents at the Atlantic Mouth of the Nicaragua Canal.

To make such a port at Brito would be a very expensive affair, and I believe that further surveys should be made to demonstrate if it is practicable or not to carry the canal to Salinas bay, which is a most magnificent harbor, and capable of holding the navies of the world.

"I am not aware that anything more than a slight reconnoissance has been made of this route, and I believe that a careful topographical survey should be made between the lake and Salinas bay, so that an opinion could be formed as to the cost and practicability of this route. I think it would be well worth while to spend a few millions more on the canal, in order to obtain the benefits of the most magnificent harbor."

Mr. Miller closes with an expression of

the sentiment recently expressed in these pages: "By all means let us have the most complete and thorough surveys, even if they cost $500,000 and three years' time, and do not let us make the mistakes of Panama by commencing work before we know 'where we are at' as regards some of the most serious problems connected with the construction of this important canal."

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Compressed-Air Work and the Hudson Tunnel.

THE MINING JOURNAL, RAILWAY, AND COMMERCIAL GAZETTE (London) is publishing as a serial a paper read by Mr. E. W. Moir before the Society of Arts in May last on the subject of "Tunnelling by Compressed Air,"—a paper which is full of interesting information, not only upon this class of work in general, but upon special matters connected with the larger undertakings of this class, with many of which Mr. Moir has been connected, notably the Blackwall tunnel now being constructed for the London county council, and the Hudson river tunnel, from which great things were expected, but which is now dormant.

It was in connection with this latter work that Mr. Moir instituted a peculiarly successful treatment for men suffering from the effects of compressed air. He says: "When I first went to New York, the men had been dying at the rate of one man per month, out of forty-five or fifty men employed,—a death rate of about twenty-five per cent. per annum. With a view to improving this state of things, an air compartment like a boiler was made, in which the men could be treated homœopathically, or reimmersed in compressed air. It was erected near the top of the shaft, and, when a man was overcome or paralyzed, as I have seen them often, completely unconscious and unable to use their limbs, they were carried into the compartment and the air pressure raised to about half or two-thirds of that in which they had been working, with immediate improvement. The pressure was then lowered at the very slow rate of one pound per minute, or even less, the time allowed for equalization being from twenty-five to thirty minutes, and even in severe cases the men went away quite cured. The medical lock should be used at once, as it does not appear to have much effect after some time has elapsed. Such an appliance had never been used before it was introduced by us at the Hudson tunnel. Fortunately there have been no deaths, but there have been some cases of paralysis which were immediately cured in the lock, and there have been a few cases of vertigo, one of which was more or less permanent, though the man is slowly recovering. The great necessity is to have plenty of air, and, as the pressure increases, purity must be greater."

Mr. Moir attributes the bad effects largely to carbonic acid, and especially to a sudden simultaneous increase of pressure and impurity. He advances the suggestion that, under increased pressure, the blood actually dissolves an excess of carbonic acid, which is suddenly liberated when the pressure is removed, and he advocates the passing of all air intended for high-pressure caisson or tunnel work through lime-water, which will absorb and remove the excess of carbonic acid. He would examine applicants for work carefully, rejecting any with a tendency to apoplexy or heart trouble. Sparely-built men, not too full-blooded, he considers best adapted to the work. At the Blackwall tunnel no deaths have occurred, although the men are working under thirty-seven pounds pressure. The good record Mr. Moir attributes to the use of the medical lock and the careful observation of the points learned by experience.

It may be of interest to quote his summary of the work done on the Hudson river tunnel, and the present status of that undertaking. "The Hudson tunnel was commenced in 1879, and is the first tunnel in which compressed air was used, although, as already stated, it was suggested by Admiral Cochrane in 1830. It was driven entirely through soft river mud or silt, so fluid that it will flow through a slit ⅛-inch wide for weeks against a pressure little less than the hydraulic head. About 2,000 feet were driven by means of compressed air, and what is known as the pilot system of tunnelling, invented by Mr. Andersen, a Swede, and first applied in the Hudson tunnel by him. Very good progress was made by this means, but, as the tunnel was extended further under the water and approached nearer the river-bed, the silt became more fluid, and the air pressure necessary to keep it back at the bottom was more than the reduced depth of mud above would stand, and several blow-outs occurred. It became necessary, therefore, to introduce the shield and cast-iron lined system to make further progress, and in 1889, on the recommendation of Sir John Fowler and Sir Benjamin Baker, and Mr. Greathead, Messrs. S. Pearson & Son were entrusted with a contract for carrying on the work, some fresh capital having been raised in England; and I represented them upon the works. The shield, which weighed about 80 tons, was put together 2,000 feet out from the Jersey shore of the river, under a pressure of over 35 lbs. per square inch above the atmosphere. It was a very difficult job, having to be rivetted up by unskilled men, but it was ultimately got to work, and made good progress until financial difficulties again beset the company. During the twelve months that the shield was working, however, nearly 1,900 feet were constructed under an air pressure of 30 lbs., and as much as 72 feet of completed tunnel were fixed in one week. Out of 5,500 feet in all, there only now remain some 1,600 feet to complete to make a connection between New York and Jersey City, and there is no doubt that money will be forthcoming some day to finish this work, which cannot fail to be an important connecting link between New York and the mainland, from whence nearly all the main western trunk lines start."

The Rapid Evolution of Engineering.

PRESIDENT THOMAS CURTIS CLARKE'S address before the annual convention of the American Society of Civil Engineers at San Francisco, on June 30, is full of excellent things, clean, telling, epigrammatic, and forms a striking exposition of the dignity of the profession and its integral relation to the progress of the world, both in practical and intellectual matters.

The essential characteristic of the engineer he considers to be the scientific habit of observation, deduction, and experiment. Exercised *per se* in the natural world, the resultant would be discovery, pure and simple; combined with the conception of adaptation to human needs, it becomes creative. The engineer may not necessarily be an investigator, but he must be quick to understand the investigator's work, and interpret it in terms of useful application and practical service.

Mr. Clarke, in a brief summary, suggests the many highly-specialized branches into which the profession is now divided. Apart from military engineering, he distinguishes "structural, mechanical, electrical, metallurgical, hydraulic, mining, agricultural, chemical, sanitary, municipal, highway, and railway engineering. These classes are again subdivided; as hydraulic engineering into canal, harbor, water-supply, power, storage, and irrigation engineering; or railway engineering into bridge, foundation, track, signaling, locomotive, and car engineering." All these Mr. Clarke would include under the one general head of civil engineering, abandoning the restricted and at the same time indefinite sense in which this term is generally understood, and returning to the primary sense which it bore when the entire profession had but two departments,—"Military" and "Civil."

This almost overwhelming catalogue suggests the rapid expansion and specialization which has taken place under the influence of modern tendencies, and the radical change involved to older members as well as to those just entering the work. We have been passing through an era of extraordinarily rapid change, no doubt often bearing hard upon those whose lack of equipment or of adaptiveness prevents them from continuously adjusting themselves to a rapidly-changing environment.

Like many other lines, engineering is becoming "commercialized" as well as specialized. Much of the work which formerly sought the individual now goes to large construction companies; but the increased facilities and economies attending the new method lead to more and larger undertakings. And the net result is a demand for still higher skill and more workers. Railroad construction may diminish, but railway operation absorbs even more engineering talent for its maintenance of way, its shops, its signals, and its superintendence. The final settlement of boundaries takes away the occupation of the once important surveyor, but the growing municipality requires a score for its public works and private buildings.

And the end is not yet,—nay, this is but the beginning. The tendency of the future will be steadily toward a broader and more diversified extension of the work of the engineer. The profession has better openings now than it ever had before, but he who builds his career within its lines must lay his foundations broad and deep, so that there may be room to erect safely upon them a structure which may require unexpected modification in the building. There is much short-sighted criticism of engineering schools for amplifying their courses with studies of which the impatient "special student" does not see the value in relation to his chosen branch of work, simply because, as a rule, neither he or the critics who join with him have had experience to teach them how inextricably the applied sciences are interwoven, and how many things ought to be somewhat familiar even to the close specialist.

The engineer, above all, must realize the definition of a gentleman (Lord Chesterfield's, was it not?) and know "something of everything, and everything about something." The graduate's path often takes an unexpected turning, and an elective or optional study may become unexpectedly important in his after career.

Japanese Marine.

AN extract from the Japanese *Weekly Mail*, reprinted in the *Board of Trade Journal* (London), presents the views of the ex-chief of the Japanese ship-control bureau, as given by him in a recent lecture before the Toho Kyokai (Oriental Association), upon the Japanese navigation encouragement bill, which has followed the action of the Tokyo chamber of commerce mentioned on page 144, current volume. On the whole, he gives the bill a general approval, but criticises it in certain respects. He thinks a distinction in the matter of subsidy ought to have been made between foreign-built vessels and those built in Japanese dockyards, and that provision ought to have been made for home competition.

Reference to the review on page 144 will show that the board of trade desired that Japanese shipbuilders should be subsidized, and that subsidized yards should be favored.

He is not content with present facilities for the training of officers and sailors, which he regards as inadequate. Nevertheless, he believes that the result of the enactment of various navigation laws, some of which have secured the approval of the diet, and the subsequent expansion of Japan's maritime business, will be to affect the resources of Hong Kong: a gradual transference of the right of coasting in China and Japan will follow, and regular services to the South Seas will afterwards be undertaken by Japan. He believes Japan's greatest commercial centre will be Tokyo, and he cannot but marvel that the citizens are apparently indifferent to the important question of the reconstruction of the harbor of that city.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

Bridges.

6555. The South Rocky River Bridge (Illustrated description of a high level viaduct built near Cleveland, O., which shows quite a departure from the usual style. Special pains was taken to secure an improvement from an architectural standpoint). Eng Rec—June 13. 1500 w.

*6588. Railway Bridges for Branch Lines. M. A. Pollard-Urquhart (Read at meeting of Soc. of Engs., London. Deals with public road bridges over the railway, public road bridges under the railway, bridges for occupation roads, and bridges over water courses). Arch, Lond-June 5. 2500 w.

†6647. The Strain Sheet and Estimate of Cost for a Pratt Truss Highway Bridge. A. B. Loomis (Assumed data are given for the case under consideration, with determination of weight or dead load, calculation of stresses, estimate of material and estimate of cost). Tech-May, '96. 1700 w.

†6667. The North River Bridge. G. Lindenthal (Illustrated description of the general technical features of the undertaking. The characteristics of the superstructure, foundations, peculiarities of end spans, method of erection, and comparison with other large bridges). Trans Assn of Civ Engs of Cornell Univ-June, '96. 4900 w.

*6695. The New Bridge Over the Seine (A somewhat minute description of the Mirabeau Bridge. It possesses many features of originality in its details). Engng-June 12. Serial. 1st part. 2200 w.

6968. Rock River and Merrimac Bridges, Chicago & Northwestern Ry. (Illustrations and description of the essential features of interest to engineers of the two bridges recently completed by this road to replace old bridges. (Eng News-July 9. 1600 w.

Canals, Rivers, and Harbors.

6522. The Dry Dock at Kingston, Ont. Henry F. Perley (Read before the Canadian Soc. of Civ. Engs. Illustrated description). Can Eng-June. 2500 w.

†6662. The Kampsville Dam. S. T. Morse (Illustrated description of the location, design and construction, with time, cost and durability statement). Tech-May, '96. 1700 w.

†6663. The Transportation of Solid Matter by Rivers. William Starling (An interesting study of this subject, giving theories of noted writers). Trans Assn of Civ Engs of Cornell Univ-June, '96. 9000 w.

†6664. Description of a Break on the Erie Canal. Albert J. Hymes (The large break that occurred at Pattersonville, ten miles west of Schenectady, on June 5, 1895. The cause supposed to be some defect in the culvert. The construction of such culverts is illustrated and described). Trans Assn of Civ Engs of Cornell Univ-June, '96. 3000 w.

*6672. The River Indus and the Best Method of Embanking It. G. M. R. (Traces briefly the stages through which the river must have passed, and offers methods for improving its condition). Indian Forester-April. 10800 w.

Hydraulics.

†6671. On the Flow of Water in Branching Pipes. A. L. Colsten and R. H. Keays (Account of recent experimental researches made in the hydraulic laboratory of the College of Civil Engineering of Cornell University). Trans Assn of Civ Engs of Cornell Univ-June, '96. 1200 w.

†6866. The Hydrology of the Mississippi. James L. Greenleaf (A brief but interesting discussion from the point of view of the engineer, based upon a report made by the author in the tenth census of the United States. Sixteen branches of the Mississippi are considered, and diagrams and tables accompany the discussion). Am Jour of Sci-July. 5500 w.

Irrigation.

†6650. Flow of Water Through Siphons. Milo S. Ketchum (Account of experimental researches made in the laboratory of applied mechanics in the Univ. of Illinois, with tabulated data and engraving of apparatus employed). Tech-May, '96. 1700 w.

†6811. The Stepchild of the Republic. William E. Smythe (A discussion setting forth the importance of Arid America, its size and character. The Carey law and what it has done and will do for the situation. Steps necessary for the final solution of the problem). N Am Rev-July. 3800 w.

*6554. The Admixture of Kentish Ragstone With Portland Cement (The report of Dr. W. Michaelis, Berlin, to the London Chamber of Commerce, interesting as being an additional proof of the fallacy of deductions drawn from tests of neat cement). Engng-June 5. 1400 w.

*6571. The Design of Derricks. Benjamin F. La Rue (The object of the article is to explain how the stresses may be accurately computed and the material properly proportioned for the ordinary boom derrick). Stone-June. 2500 w.

†6653. An Investigation of the Relative Strength of Hydraulic Cements. H. C. Estee (Investigations based on data of reports of tests made by about twenty city engineers and by several cement dealers. A table gives the average strength of each class at various ages). Tech-May, '96. 1000 w.

†6654. The Effect of Grinding Mixed Sand and Cement. H. E. Reeves (A summary of results of a series of experiments undertaken in the Cement Laboratory of the University of Illinois). Tech-May, '96. 800 w.

†6666. Holland's War With the Sea. J. H. Gore (A discussion of the conditions under which this annex to the continent was made, the technical processes employed by the people to keep back the waters, and its effect upon the character of the people. A very interesting paper). Trans Assn of Civ Engs of Cornell Univ-June, '96. 8000 w.

6765. Transverse Tests of Beams of Oregon Pine (Douglas Fir) (Letter from William Hood, chief engineer of the Southern Pacific Co., with a memorandum concerning transverse tests of 60 beams of Oregon pine, and a table giving a summary of results and figures of moduli of elasticity and fibre stress). Eng News-June 25. 2000 w.

6890. Cement from Blast Furnace Slag (Account of a series of experiments made at the North Works of the Illinois Steel Co. in Chicago, which lead to the conclusion that this cement, like the Roman, will stand the test of time. The conditions which form the basis of this conclusion are given, the process described and a statement of practical results). Ry Rev-July 4. 1400 w.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading, and Architecture.

Reduction of Relay Resistance in Telegraphy.

COMPARATIVELY recent changes in telegraphic practice are neither few or unimportant, though the remarkable advances in other and newer fields of electrical engineering have diverted public attention from the quiet progress constantly made in the older art. This progress and personal experience furnish themes for an interesting, though rather short, paper read by Mr. U. J. Fry before the June meeting of the Association of Railway Telegraph Superintendents, reported in *Electrical Review* (June 24).

The earlier practice began with relays of much less resistance than have since been employed. From 100 to 150 ohms the resistance was increased to 225, 350, 400, and, in some cases, 500 ohms, 400 ohms, as Mr. Fry states. having been thought the proper thing on the road where he was first employed. But there was also great want of uniformity in the resistance of different relays used on the same line. Uniform resistance in relays gave good results, except in foggy and rainv weather. When Mr. Fry came to the road where he is now engaged, a uniform resistance of 150 ohms had just been adopted. To meet the difficulties experienced in wet weather, he first inspected the insulation carefully, and, finding it good, turned his attention to other means of improvement. What was wanted was a reduction of resistance in the circuits, and this was accomplished by the substitution of multiple relays for series relays, the substituted relays having a resistance of 37½ ohms instead of 150; and he also employed wire in which the resistance of the circuit did not exceed that of the instrument.

" The circuit chosen was a Milwaukee to Oshkosh No. 8 gage wire, 104 miles in length, measuring about 15 ohms per mile, or 1,500 ohms, with 35 relays in circuit; relay resistance, 5,270; total, 6,810. After replacing the old with the low-resistance relays, we found the total resistance to be 2,872,—a difference of 3,938, or the amount of relay resistance taken out. We then reduced our batteries from 150 to 75 cells. After working this wire for six months in this way, we noted the following comparisons: prior to the change, the wire did not work in the best of weather satisfactorily, and in foggy and rainy weather very unsatisfactorily, and at times we were unable to work more than half way. The current in bad weather fluctuated so that it was impossible for the operators to keep their instruments adjusted. After the change, the wire worked perfectly in any kind of weather."

Mr. Fry says, with reference to the extension of the system to other circuits, that he has not reached perfection in all the circuits on the road, the conditions not being the same; but he makes the following interesting statement:

" We have seven circuits arranged in this manner. We are doing business right along, irrespective of the condition of the weather. One of our circuits, 200 miles in length, equipped with this class of instruments, did not at first give us the desired results, and we were considerably annoyed in bad weather. We placed a 50-cell battery in the middle of this wire, which resulted in a decided improvement. While this circuit may not work quite as well as shorter ones arranged in this manner, it has improved it wonderfully; so much so, that our dispatchers are able to handle trains in all kinds of weather, without delay.

"Prior to the change, our Chicago to Savannah dispatchers' wire, 138 miles in length, worked so badly in rainy weather that at times we were unable to work with Elgin, a station 35 miles out of Chicago. This circuit was a new No. 8 gage iron wire, new line of poles, insulation as perfect as glass could make it. After we changed to the lower resistance instruments, our dispatchers were able to work the wire its entire length with about the same degree of rapidity in rainy weather as in dry weather. Without having tried, it is our opinion, however, that, if we should equip this circuit with 25-ohm relays, and place a battery of, say, 30 to 50 cells in the middle, we would secure still better results.

"We have been experimenting with a 25-ohm relay on one 200-mile circuit, and are meeting with exceptionally good results. We find that, during a thunder and lightning storm, this relay performs much better than the 150-ohm relay. When it is affected by lightning, it discharges so quickly that it obliterates only a letter or two, instead of a word or two, as is the case with the old instruments. We expect to equip the entire circuit with 25-ohm relays in the near future. We do not wish to be understood as claiming that 25 ohms is the proper resistance; but we have met with such encouraging results that we are going to give them a trial."

This experience is decidedly favorable to the use of low-resistance relays, and doubtless will lead other railway superintendents to experiment in reducing circuit resistance. No application of telegraphy can be of greater importance than railroad work, and in no other use are interruptions of communication of such inconvenience and even danger.

Insulation of Grooved Armatures.

THE difficulties that have been experienced in insulating grooved armatures, and which have, in some measure, deterred manufacturers from using them, are held by Mr. William Baxter, Jr., in *American Machinist* (June 11), to be not as formidable as has been imagined. It simply requires a recognition of what are really the weak points, and a knowledge of the requirements for their protection, to enable manufacturers to overcome all the difficulties, and to make the insulation as substantial and permanent with the grooved type as with the smooth core; and this without materially increasing the cost of construction.

A U-shaped piece or trough of mica accurately fitting the groove for machines working with an electro-motive force of more than one hundred and ten volts, and of proper thickness, is the best insulator for the sides and bottoms of the grooves. Sheet fiber rendered water-proof by saturation with paraffine will, however, answer well for machines used in buildings. The mica troughs can be made of thin plates of mica stuck together with copal varnish, tempered with raw linseed oil to make it tough.

Other ways of using mica are described and illustrated in Mr. Baxter's article. He points out that the insulation is most likely to give out at the ends of the grooves, and presents a practical way of obviating this difficulty, closing with a statement of the necessary thicknesses of mica for machines working under different voltage.

An Electric Trevelyan Rocker.

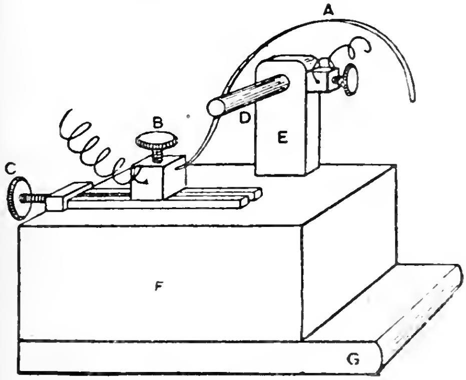
THE Trevelyan rocker is a well-known piece of physical apparatus used to demonstrate the intensification or increase of molecular motion in solids by sudden increase of temperature in contact points. A bar arranged to rock easily is placed upon another body in such manner that in rocking it rests alternately upon different small surfaces of contact. If one of the bodies has been heated, the sudden expansion of the alternate points of contact will react upon the rocker, and cause it to oscillate from one point of contact to the other in rapid succession. A similar phenomenon is sometimes observed when a flat-bottomed tea kettle filled with cold water is placed upon a heated range in such manner that it does not stand evenly and firmly. This action is explained with great clearness in Tyndall's lectures on

"Heat as a Mode of Motion," and is also described in many other text-books of physics.

The Electrical Engineer (June 24) has a reprint from the London *Electrician*, describing a curious electrical phenomenon, contributed to the last-named paper by Mr. T. A. Vaughton. This phenomenon occurs with an apparatus which Mr. Vaughton provisionally calls an electric Trevelyan rocker.

The arrangement of this apparatus is seen in the accompanying engraving.

A piece of watch-spring, A, curved into the shape shown, is fixed into the terminal, B. This terminal moves along a slide and



AN ELECTRICAL TREVELYAN ROCKER.

carries the spring with it, and, by means of the screw, C, the pressure of the spring against the metallic rod, D, is regulated. This rod is supported by a wooden support, E, and the whole is fixed upon the top of a wooden sounding-box, F, which has a projecting piece, G, by means of which it may be clamped down to the bench when in use. On regulating the pressure with which the spring presses against the rod, and the position on the spring of the point of contact, a point will be found on which the spring, when pulled on one side and released suddenly, will vibrate freely in a transverse direction. If, while the spring is thus vibrating, an electric current of definite strength be passed through the bar and down the spring, the vibrations will be maintained and a musical note will be given out, the pitch of which depends on the length of the free end of the spring. The temperature of the spring and rod gradually rises, until a point is reached at which the vibrations cease.

If the apparatus is immersed in water or alcohol just deep enough to cover the point of contact between the spring and rod, the vibrations take place as before, but the sound emitted is weaker. By placing a small split bullet in various positions on the free end of the spring, the rate of vibration may be varied and the amplitude increased, and, by fixing a small concave mirror upon the spring and reflecting a spot of light from it upon a screen, the vibrations may be magnified and observed.

The steel spring may be replaced by one of platinum or German silver, but in these cases the vibrations are more feeble. Rods of almost any hard metal may be used, but steel gives the best results, and is followed by iron, German silver, platinum, brass, gas carbon, aluminum, and nine-carat gold, in the order named.

Mr. Vaughton says he has not been able to obtain any sustained vibration with rods of copper, silver, tin, and lead, although even with these metals the dying away of the vibration appears to be considerably retarded by the passing of the current. No visible sparking takes place, and there seems to be no interruption of the current.

These phenomena appear to be the effects of the heat generated at the point of contact, although the fact of their taking place under water would at first sight seem to negative this assumption. Mr. Vaughton adds that he has failed to get any results with springs of good conducting metals, such as gold, silver, and copper.

Lord Kelvin and His Life-Work.

THE fiftieth anniversary of Lord Kelvin's professorship in Glasgow University has been made a general and welcome occasion for paying homage to his genius and character. Fifty years of honorable service in such a capacity during a period of entirely unprecedented scientific activity means a great deal. It means untiring zeal and physical ability to bear up under a constant strain of hard work. No man, however gifted by nature, could have maintained the commanding position before the scientific world that Lord Kelvin has held during this period without labor that would have broken down the majority of men. The admiration his intellectual powers and other great qualities have excited is fully justified by his achievements. The literature and the appliances of scientific work have been enriched by his work, and on all departments of science the influence of his life and example has been far-reaching and enduring. It is fitting, therefore, that scientific and technical journals should review the results of such a life, and that those of his own land should dispose much space to the grateful task of recording his works.

In particular *The Electrician* (June 19) prints three separate and able articles, the titles of which are, respectively, "Lord Kelvin's Researches," "Lord Kelvin and Submarine Telegraphy," and "The Electrical Measuring Instruments of Lord Kelvin." These titles are significant of the phenomenally broad grasp of this veteran. Theory, practice, invention, the power to impart instruction (added to a singular power of original investigation), and unswerving devotion to science for its own sake, are all implied in these titles. And, when it is remembered that, having passed by more than a decade the three-score and ten years allotted to man, Lord Kelvin is still in harness with unimpaired intellect and physical health rare at his age,—that he is still at work and enjoying work,—we shall find it difficult to recall many lives that, in every respect, can be compared with his in its grand accomplishment.

Though his fame will rest mostly upon his work in the electrical field, it would be a mistake to suppose that this field has confined his powers. We see his name so frequently now in connection with electrical science that perhaps many have come to regard him as purely an electrician. *The Electrician* says:

"He has worked in the most diverse lines. With the whole gamut of applied mathematics at his finger-ends, he has applied it to the laying of telegraph cables and to calculate how best to signal through them; how best to compensate for the action of the iron in ships on their compasses, and how to predict the tides; how to measure temperature and electricity; how to calculate the age of the earth and the size of an atom. In each of these lines and in many others he has made important contributions to the sum of human knowledge, and has improved the opportunities of human activity.

"Lord Kelvin's mathematics is of the specially powerful type that distinguishes such giants as Laplace and Green. He is determined at all costs to solve the question, and does not give up because it leads to laborious approximations and complicated series. He rejoices no doubt in elegant methods, as, for example, in the theory of electrical images; but what some would consider inelegant and sledge-hammer methods are at hand to obtain the result. His mathematics is for the sake of the result, and not for the sake of the mathematics. He has especially developed the methods of physical investigation depending on the principles of the conservation of energy, and the popularity of these methods owes a great deal to his powerful example."

Hydrodynamics, thermodynamics, the theories of elasticity and of optics, have each been largely advanced by his labors. As an inventor he holds high rank. His method of rapid sea-sounding for use on ocean-going vessels is alone enough to establish this claim. His apparatus for sounding is now a standard appliance on ocean-going steamers. His siphon recorder would also be enough to establish the fame, as an inventor, of any man. But, having paid this tribute to the magnificent genius of one of the ablest of living electricians, we must leave the long enumeration of his noble achievements to others. The three articles named in this review will well repay perusal, as a record of what earnest, persevering work can accomplish in the short span of one human life. The honors paid to Lord Kelvin are made more brilliant by the modesty of their recipient.

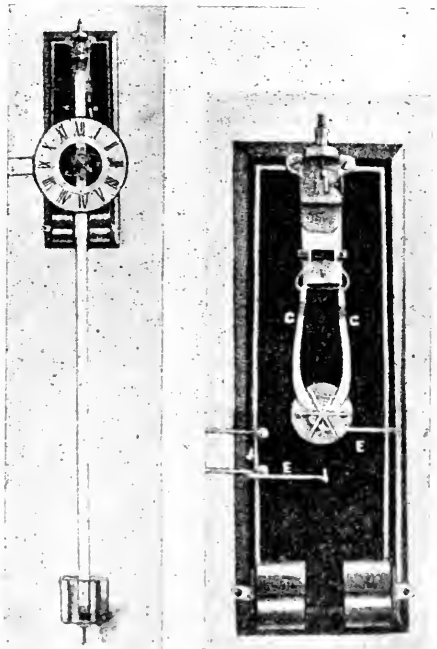
The Hayden Century Clock.

THE use of electricity in horology dates back well toward the general introduction of electric telegraphy. Among the first applications was the employment of an electric current and electro-magnets to control the movements of clocks, by thus connecting them with a master-clock sometimes at a long distance from the clocks regulated by it. Next, the master-clock was made, at each beat of its pendulum, to form an electric circuit, which moved hands on a distant dial, whereby the time indicated by the master-clock could be shown as well on the remote dial as on its own dial. It was but a step from this to the substitution of electric power for the weights or springs previously used for actuating clock-works, and which required periodical winding. However, comparatively little has yet been done in driving clocks by electricity. An example of such a clock, described and illustrated in *The Electrical Engineer* (May 27), has been designed and constructed in Trinity College, Durham, N. C., by Mr. J. F. Hayden. The current for this clock is derived entirely from an earth battery having a quantity of old furnace grate-bars for one electrode, and a mass of coke for the other, both buried in the earth near the building in which the clock has been placed. It is expected that this battery will supply the power needed for a period of from fifty to one hundred years, and this has probably suggested the name used as the title of this review and of the description given in *The Electrical Engineer*, of which the following is a condensation.

The pendulum, which is also the driver, has a wooden shaft, and heavy cylindrical weights for the bob, and is suspended from the bracket attached to the back-boards (Figs. 1 and 2). An automatic switch, C G, sends the current around first one and then the other of the electromagnets, D and H. The screw, A, at the upper end of the pendulum is electrically connected to the upper binding post, J, and also to two contact points, one on each side of the shaft at L. The arms, C and G, of the automatic switch are insulated from each other. The upper arm, G, is in metallic connection, through the central screw, with a wire in the rear of the back-boards, leading to the coils about the pair of magnets, H. The lower arm, C, rests on the brass plate, F, the latter being connected with the coils about the magnets, D.

As the pendulum swings, the current alternately passes around the two pairs of electromagnets, D and H, and the two soft-iron armatures at I are alternately attracted.

Starting from the upper of the binding posts, J, the current passes to A, then through the piece of sheet steel, B, at-



THE HAYDEN CENTURY CLOCK.

tached to the upper end of the pendulum shaft, to the contact points, L. When the pendulum starts from the magnets, H, towards the magnets, D, the contact is made from L through C, and the current will pass around magnets D, and from there to the lower binding post, completing the circuit through the battery. This aids the force of gravity in carrying the pendulum towards D. When the pendulum starts back from D, the contact is made with G, and the current passes around the magnets, H, giving the pendulum a pull in that direction. If these pulls at each stroke of the pendulum are sufficient to overcome the loss by friction of the moving parts, it will continue to vibrate.

To regulate the amount of current passing to the electromagnets, two brass tips are affixed to the shaft at K, their distance apart being readily adjusted by screws. Shortly after the contact is made with C, as the pendulum swings toward D, the connection is broken by the arm, C, coming in contact with the strip, K, on that side, and, if the current is very strong, the strip will push the switch far enough to throw G into contact, and the current will pass around the magnets H. The latter action will tend to retard the motion of the pendulum toward D. By adjusting the distance between these strips, almost any current may be used to run the clock.

The works and dial are placed upon the pendulum and swing with it. The seconds hand is attached to a ratchet wheel having sixty teeth, and is actuated at each stroke of the pendulum by the pawls, E E, which are attached to the back-board. The motion is communicated to the minute and hour hands by the usual intermediate wheels. The movement is jeweled, and the pawls have steel tips. The tips of the pawls work in semicircular grooves in such a manner as to make it impossible for them to catch more than one tooth at each stroke of the pendulum. The length of pendulum is adjustable both at the upper and at the lower end by means of suitable screws.

The lower end of the pendulum is provided with two needle points fixed in the nut, n. These pass simultaneously through two drops of mercury, each of which is in metallic connection with one of the binding posts at the right-hand lower side of the case. Thus we have a clock that may be used in many laboratory experiments where a seconds pendulum is required. A local circuit may be closed through an electric bell or telegraph sounder at each stroke of the pendulum.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Applied Electricity in the American, English and British Colonial Electrical and Engineering Journals—See Introductory.

Lighting.

*6510. A Practical Exposition of Electric Lighting. Wm. A. Anthony (An elaborate review of Prof. Crocker's recent book). Eng Mag–July. 3800 w.

6845. Municipal Ownership of Electric Plants (Editorial on the subject referring to paper of Allen R. Foote, read at the Street Lighting Convention in New Haven). Elec Eng–July 1. 1400 w.

6895. Electric Street Lighting. M. J. Francisco (Statements and arguments from a business standpoint. Reports and figures are from a personal examination of plants. Favors private ownership). Pro Age–July 1. 5000 w.

*6905. Lighting Country Residences and Institutions. Henry Stooke (A description of the Scott-Sisling system). Ill Car & Build–June 26. 1000 w.

6950. Alternating-Current Stations and High Voltage Lamps. H. W. Couzens (Read before Municipal Elec. Assn., England, a brief consideration of the subject, with discussion). Elec Rev–July 8. 2500 w.

6956. On the Cause of Continuous Spectra in Exhausted Tubes. W. H. Birchmore (A speculation as to its possible origin, with description of phenomena). Elec Eng–July 8. 2700 w.

6957. Some Central Station Economies. P. G. Gossler (Abstract of a paper read before the Canadian Elec. Assn. Results obtained from the partial reconstruction of a plant). Elec Eng–July 8. 3500 w.

6963. Some Faults in Arc-Lamp Carbons. W. M. Stine (Points relating to arc-lamps and especially arc light carbons which should be considered by manufacturers). Elec Wld–July 11. 1200 w.

6964. Electric Lighting on the Steamer "Adirondack" (Illustrated description). Elec Wld–July 11. 800 w.

Power.

6521. Electricity from the Wind. E. O. Baldwin (Abstracts from a paper read before the Netherlands Society for the Promotion of Industry, Haarlem, Holland. Refers to unsuccessful undertakings and describes a successful system). Can Eng–June. Serial. 1st part. 3500 w.

6573. The Total Efficiency of Certain Central Stations. E. A. Merrill (A survey of the subject from the stand point of actual practice). Elec Engng–June. 2400 w.

*6593. Electrical Equipment for Mines (Brief directions of points that should have attention in the introduction of this form of power, with estimates of approximate cost. motors used, and recent improvements). Ir & Coal Trds Rev–June 5. 2800 w.

*6603. Phenomena of Commutator Resistance. H. J. Edsall and M. C. Rorty (Experimental study of brush contact resistance with summary of results). Sib Jour of Engng-June. 1100 w.

*6606. A Study of a Three-Phase Motor. C. W. Van Law and H. S. Simpson (An abstract of a test of power measurement, etc., conducted in the laboratories of Sibley College). Sib Jour of Engng-June. 2000 w.

*6608. The Sibley College Multi Phase Generators. L. A. Murray and H. H. Norris (Machines are described). Sib Jour of Engng-June. 900 w.

6609. Electric Lighting, Heating and Power Plant of the New Boston & Maine and Fitchburg Union Station, Boston (Illustrated description). Safety V-June. 3300 w.

6617. How to Get Different Kinds of Currents in a Cheap and Simple Way for Experimental Work. F. Jarvis Patten (An article prepared in the hope of making clear to those who do not possess sufficient theoretical knowledge to work unaided, how the different kinds of current may be obtained from a direct current). Am Elect'n-June. 1400 w.

6619. Methods of Starting Induction Motors, P. M. Heldt (A review of the different methods). Am Elect'n-June. 1200 w.

6639. The Action of the Shunt Motor. William Baxter, Jr. (Explanation of the principles upon which the close regulation of speed in shunt-wound motors depend). Am Mach-June 18. 1300 w.

6643. Electro-Aerostatics. S. D. Mott (Illustrated description of machines for scientific investigations, and other uses). Elec Wld-June 20. 2200 w.

6644. The Mistakes That May Be Made in Consequence of the Prevailing Tendency to Reduce the Speed of Electrical Machinery. William Baxter, Jr. (A review of the subject in its various applications). Elec Wld-June 20. . 1900 w.

†6651. Alternate Current Motors. Bernard V. Swenson (Descriptive of the different varieties of alternate current motors). Tech-May, '96. 4200 w.

†6652. The Alternate Current Transformer. J. D. Morse and J. E. Pfeffer (Description of researches with table of principal observations and calculations, and diagrams). Tech-May, '96. 5000 w.

*6697. An Interesting Electric Power and Light Plant (An extract from circular issued by the Electric Company, Limited, of London, describing some of the more special features of the electric power and light plant constructed at the free docks of Copenhagen). Prac Eng-June 12. 2800 w.

*6719. Wolverhampton Electric Supply System (Illustrated description). Elect'n-June 12. 4000 w.

6732. Electric Light and Power on a Railway Dock. H. C. Hope (Read before the Assn. of Ry. Telegraph Supts. Equipment of the dock C., St. P., M. & O. Ry. at Itasca, Wis). Elec Rev-June 24. 500 w.

6749. The Care of Commutators. Charles Wirt (The tendency of commutators to develop flat spots, similar to wear of car-wheels, and showing that this is not necessarily due to faulty construction, with suggestions for treatment). Am Mach-June 25 1000 w.

6750. Electrical Tests of Power Consumed by Rolling-Mill Machinery. Reported by E.H. Wise, Electrician of the Cambria Iron Co. (Tests of lathes, saw, presses, punch for rails, traveling crane, etc). Am Mach-June 25. 1400 w.

*6757. The Power of Water. C. A. Stone (The power going to waste in our streams, and the conditions under which electric transmission can be used to advantage). Milling-June. 1100 w.

6772. An Experimental Study of Electro-Motive Forces Induced on Breaking a Circuit. F. J. A. McKittrick. With an introduction by Edward L. Nichols (An attempt to describe the results of an introductory experimental study of the induction phenomena exhibited when the circuit is broken. The article was read at the general meeting of the Am. Inst. of Elec. Engs). Elec Wld-June 27. Serial. 1st part. 2400 w.

*6776. Electricity Supply at 220 Volts. A. S. Barnard (A summary of the chief points of a paper read at the Convention of the Municipal Electrical Assn). Eng, Lond-June 19. 1400 w.

*6780. Use of Electricity on Board Ships. F. Eickenradt (Read at meeting of the Inst. of Naval Architects. The subject is treated from the point of view of the shipbuilder. Lighting, ventilation, heating, gun and turret turning, winches, hoists or lifts, etc , are considered). Eng, Lond-June 19. 4000 w.

*6791. The Langdon-Davies Alternate Current Motor. Ill. (Description of a machine in which such improvements have been made in the magnetic arrangements, that the motor has an efficiency, according to Dr. Thompson's report, of 91% at its maximum power, and also at half-power, while between these limits it rises to 95%). Engng-June 19. 2800 w.

*6820. The Principles of Alternate-Current Working. Alfred Hay (Based on a series of evening lectures delivered at the University College, Liverpool. The subject is treated in a manner adapted to the comprehension of students). Elec Eng, Lond-June 19. Serial. 1st part. 2400 w.

6841. Power Plant of the City and Suburban Railway Co., Baltimore, Md. (Illustrated description) Power-July. 3500 w.

6846. On the Seat of the Electrodynamic Force in Ironclad Armatures. Ill. Edwin J. Houston and A. E. Kennelly (The authors have experimentally demonstrated that in the type of armature employed by them more than 98% of the entire torque was exerted on the iron, less than 2% being produced by the conductors). Elec Wld-July 4. 1600 w.

6847. The Baltic Taftville Transmission Plant. H. E. Raymond (Illustrated description). Elec Wld-July 4. 3000 w.

6852. The Thirty-five-mile Electrical Power Transmission of Fresno, Cal. (Illustrated description of a recently completed work. The distance is the longest yet attempted for the electrical transmission of power generated by an artificial fall of water). Lord's Mag–July. 1400 w.

*6925. The Langdon-Davies Self Starting Mono-Phase Induction Motor (Illustrated description). Elec Rev, Lond–June 26. 1800 w.

*6926. Electrical Transmission in Spain (Description with illustrations of an interesting system recently put down by Messrs. Siemens Bros. to supply light and power to Alcoy and Gandia, two towns in Valencia. The power is from the Serpio, a river running between a range of mountains, but having no natural fall). Elec Rev, Lond–June 26. 900 w.

*6936. Combined Electric Lighting and Traction Plants. John Hesketh and John H. Rider (Read before the Municipal Elec. Assn. Way in which electrical supply may be cheapened by judicious foresight and application of present knowledge). Ind & Ir–June 26. 2500 w.

6951. Electricity Supply at Two Hundred and Twenty Volts. A. S. Barnard (Read before the Municipal Elec. Assn., England. Deals with the advantages and disadvantages of the use of 220 volts on the distributing mains). Elec Rev–July 8. Serial. 1st part. 2300 w.

6965. The Storage Battery for Fire-Alarm and Police-Telegraph Purposes. John L. Hall (Explanation of the new installation which the writer has just completed for the fire alarm and police telegraph of Wilmington, Del., with illustrations). Elec Wld–July 11. 700 w.

Telephony and Telegraphy.

6529. The Storage Battery in Telegraph Work. Maurice Barnett (The almost ideal application of storage batteries for telegraph and telephone stations, fire alarm, police telegraph, burglar-alarm, and heat regulating systems. A discussion of their adaptation for this kind of work). Elec Wld–June 13. Serial. 1st part. 2400 w.

*6544. Professor Elisha Gray's Telautograph (Illustrated description). Eng, Lond–June 5. 1600 w.

6731. The New York Telephone Company (A new organization with sixteen million dollars capital). Elec Rev–June 24. 400 w.

6733. Reduction of Relay Resistance. U. J. Fry (Read before the Assn. of Ry. Telegraph Supts. The experience of the writer). Elec Rev–June 24. 1200 w.

*6804. Lord Kelvin and Submarine Telegraphy. Arthur Dearlove (A review of his work in this field showing the range of his influence on the working, testing and laying of submarine cables). Elect'n–June 19. 1700 w.

6828. Machine Shop Practice in the Manufacture of Commutators. E. L. Hayward (The object of the article is to suggest a few methods which have stood the test of practice in commutator building, and to describe the simple tools employed). Am Mach–July 2. Serial. 1st part. 1500 w.

6829. The Action of the Differentially-Wound Motor. William Baxter, Jr. (An instructive study). Am Mach–July 2. 1200 w.

6843. The Home Telephone Company's System, Mobile, Ala. (Illustrated description of an independent company, whose equipment is radically different from those generally seen. The instruments and appliances used are described in detail). Elec Eng–July 1. 4000 w.

6850. Educating Operators in the Handling of the Switchboard. W. E. Packard (Read before the Assn. of Ry. Telegraph Supts. Commenting on the inefficiency of operators and suggesting improvement). Elec Rev–July 1. 1100 w.

6854. The Berliner Controversy. W. Clyde Jones (A statement and discussion of the case). Elec Engng–July. 3800 w.

*6923. The Telephone at the Springhill Infirmary, Birmingham, Eng. (Illustrated description of a system laid down to prevent loss of time in calling medical aid to any part of the institution). Elect'n–June 26. 500 w.

6960. Inductance as a Negative Capacity in Submarine Cables. A. Davidson (Experiments, to exhibit the value of inductance as a negative capacity, made on a length of submarine cable of modern type, armored with steel wires and coiled in an iron tank). Elec Eng–July 8. 350 w.

Miscellany.

*6507. The Direct Production of Electricity from Coal. Ill. George Herbert Stockbridge (A discussion of the carbon-consuming electrical furnace invented by Dr. W. W. Jacques, and of previous experiments of other investigators). Eng Mag–July. 3200 w.

6517. Notes on Electrical Engineering Drawing. J. H. C. B. (The first part of a serial on this subject with the object of comparing some of the divergent methods and endeavoring to select the most useful). Elec, Lond–May 22. Serial. 1st part. 1000 w.

6519. A Method of Increasing the Striking Distance of a Given E. M. F. (A letter from C. E. Skinner describing interesting phenomenon observed while experimenting with high tension apparatus, which he concluded would be useful in the construction of lightning arresters. Also, letter from A. J. Wurts giving experiments and analysis of phenomenon). Elec Eng–June 10. 1900 w.

6525. How to Insulate Grooved Armatures. William Baxter, Jr. (An article showing that the insulation can be made just as substantial and permanent with the grooved type as with the smooth core, and without any material increase in cost of construction). Am Mach–June 11. 1700 w.

6527. On the Influence of Light upon the Character of the Influence Machine Discharge. J. Elster and H. Geitel (From Wied. Ann. Report upon results of experiments). Elec–June 10. 1800 w.

6528. Notes on Electrical Consonance. A. W. Chapman (Results showing the effect of capacity in the secondary of a transformer, and that the primary current may be made to lead its E. M. F. for only a limited range of capacities in the secondary). Elec Wld–June 15. 1200 w.

6578. The Electrolysis of Chlorides. E. Andreoli (Referring only to those electricians who have successfully worked their processes on a commercial scale, and who have erected electro-chemical works capable of turning out daily one or two tons of soda and chlorine, or several tons of chloride of lime). Eng & Min Jour-June 13. Serial. 1st part. 2500 w.

*6584. A Simple Method of Analyzing Periodic Curves. E. Basil Wedmore (Paper read at a students' meeting of the Inst. of Elec. Engs. The writer enunciates the principle, gives examples of its application, and proves the method analytically and geometrically). Elec Eng, Lond-June 5. 4000 w.

*6586. Computations for Coil Winding. W. Slingo and A. Brooker (A review of the points involved, with account of experiments). Elec Rev, Lond-June 5. Serial. 1st part. 1800 w.

6616. The Edison Laboratory (Illustrated description of the buildings, materials, apparatus, and work, with brief description of Mr. Edison). Am Elect'n-June. 3000 w.

6636. A Day with the Founders of Ampere. T. C. Martin (Illustrated description of the Crocker-Wheeler Electric Co. with historical account of the enterprise). Elec Eng-June 17. 6400 w.

6642. Lord Kelvin (Interesting biographical sketch of this master in science). Elec Wld-June 20. 1600 w.

*6698. The National Electrical Exhibition at New York (Illustrated description of exhibits with comments). Eng, Lond-June 12. 4500 w.

*6702. Municipal Electrical Association (Presidential address of Arthur Wright before this recently organized technical society). Eng, Lond-June 12. 4000 w.

*6714. The Cost of Electric Energy in 1895. A. P. Haslam (Estimate of the progress of the industry. The results are classified and tabulated). Elec, Lond-May 29. Serial. 1st part. 1200 w.

*6720. The Electrolytic Dissolution and Deposition of Carbon (Editorial on the articles written by Prof Vogel and Dr. Coehn, with the substance of Dr. Coehn's last article). Elect'n-June 12. 1600 w.

*6729. Do Magnet Poles Emit Light Rays? Magnes (The writer endeavors to condense in as comprehensive a form as possible an investigation as extraordinary as fascinating, and one in which the great Swedish philosopher, Berzelius, took the deepest interest). Ind & Ir-June 5. Serial. 1st part. 2400 w.

6770. An Apparatus for Determining Induction and Hysteresis Curves. Frank Holden (Illustrated description of an instrument built by the writer over a year ago, with description also of method of getting the hysteresis curve). Elec Wld-June 27. 1000 w.

*6802. Electrical Communication with Lighthouses and Light Vessels (Review of the reports of the Royal Commission on the work accomplished, with references to recent papers bearing upon this subject). Elec Rev, Lond-June 19. 3800 w.

*6803. Lord Kelvin's Researches. G. F. F. G. (A summary of his work and its benefits). Elect'n-June 19. 5000 w.

*6805. The Electrical Measuring Instruments of Lord Kelvin. J. Rennie (The practical side of Lord Kelvin's work. The investigations suited to the needs of the workman and the instruments by which these methods could be conveniently applied. His opportunities as a teacher and the lasting effect of his influence). Elect'n-June 19. 3800 w.

†6831. Photographing Electrical Discharges. Walter E. Woodbury (Illustrated description of interesting examples). Pop Sci M-July. 1200 w.

6849. The Course of Bullets Changed by Electric Currents (Account of a curious phenomenon recently observed by the committee of the Swiss Federal Rifle Meeting at Winterthur, with results of experiments). Elec Rev-July 1. 700 w.

†6900. The Transformation of the Energy of Carbon into Other Available Forms. C. J. Reed (A discussion of the subject, and a consideration of the five general methods or processes known at present, for converting this form of energy into forms directly available to man). Jour Fr Inst-July. 8000 w.

*6906. Lord Kelvin's Jubilee. A. Gray (An interesting and complete account of this successful festival, with lists of delegates and visitors, letters and addresses). Nature-June 25. 13500 w.

*6921. Chemical Effects of the Electric Current. Reginald Gordon (Lecture delivered before the Henry Electric Club. Brief mention o-the various ways the chemical effects of elecf tric currents are being utilized). Elec Pow-July. 2400 w.

*6924. The Control by Municipal Authorities of Consuming Devices and the Wire Connecting Them to the Mains. C. H. Wordingham (Paper read before the Municipal Elec. Assn. Points in connection with the question which are of importance to municipalities in possession of electric supply stations). Elect'n-June 26. 5000 w.

*6933. Thermo-Electric Reactions and Currents between Metals in Fused Salts. Thomas Andrews (Results of extended experimental inquiries by the author on this subject). Ind & Ir-June 26. 2800 w.

*6935. Cost of Electricity Supply. Arthur Wright (Read before the Municipal Elec. Assn. A description of the modifications of method, and the results of analyzing by them the figures obtained from the central supply station of the Brighton Corporation). Ind & Ir-June 26. Serial. 1st part. 3200 w.

6958. Electric and Magnetic Research at Low Temperatures. J. A. Fleming (A discourse delivered at the Royal Inst. Description of the latest results in the department of low-temperature investigations). Elec Eng-July 8. 2500 w.

6966. Effect of Temperature on Insulating Materials. Charles F. Scott (Statement of results obtained by Mr. C. E. Skinner in his work in this line). Elec Wld-July 11. 1300 w.

INDUSTRIAL SOCIOLOGY

Sound Money the Safeguard of Labor.

THE clamor of the silverites at the present time seems to sober economists so utterly senseless that any explanation of it, except such as would suffice to explain the dancing mania of the middle ages, seems inadequate. The arithmetic of the subject seems so simple and so easily comprehended; the precedents of depreciated money are so plentiful in history, and the effects of such money upon industry and commerce have been so uniformly disastrous in the past,—that, were it not a fact that an aged and experienced statesman left the party to which he has belonged and which he has served many years simply because it declared against silver in the St. Louis convention, the possibility that a man of this character, in his sober senses, could so act would be almost incredible; while that he could be the leader of a party bolt based entirely upon such a contention is yet harder to comprehend. That these bolters are, for the most part, sincere in their advocacy of silver is not doubted; the puzzle is to fix upon the quality of mind that can ignore the plainest logic and persistently hold the views advocated by them.

If a farmer had cattle to feed, and had corn and potatoes to feed them with, and if corn were worth twice as much as potatoes as feed for cattie, and if a law were to be enacted making a bushel of potatoes the equivalent of a bushel of corn in the payment of any kind of contract indebtedness, it is possible these silverites might be able to see that the farmer, above postulated, would fill any standing contract he might have made for the delivery of corn with potatoes. Thenceforward contracts for corn-delivery would mean potato-delivery. That which is intrinsically the most valuable would be kept. The corn debtor would largely gain, and the corn creditor would equally lose. The analogy of such legislation with what is proposed by the silver faction is perfect. The debtor class is to be benefited at the expense of the creditor class. The injustice of such a proposal revolts consciences not stultified by self-interest. But there are other consequences that cannot fail to be realized, should this scheme succeed.

Hon. R. B. Mahany in *The North American Review* (July) makes a strong argument upon the proposition that sound money is the safeguard of labor. Suppose that sixteen ounces of silver be made the legal equivalent of one ounce of gold, "whereas it takes thirty-one ounces of silver to purchase one ounce of gold in any market of the world, American or European; . . . who," Mr. Mahany asks, "would be the chief sufferer by such a policy?"

"Not the banker or capitalist, against whom the silver people are attempting to raise such hue and cry. The brains that understand finance and accumulate great fortunes can be depended upon to escape with a minimum of loss; but the maximum of disaster would fall upon the American laborer.

"The moment the free and unlimited coinage of silver at the ratio of sixteen to one is adopted, that moment, in all the markets of the world, our silver dollar will be rated, not at its stamped value, but at its real value of 51 or 52 cents. Sixteen ounces of silver are worth only about one-half of an ounce of gold, and hence our silver dollar at the ratio of sixteen to one will be worth only about one-half of a gold dollar. Every man who has a dollar in gold will keep it, if he can pay his debts with a silver dollar worth only half as much as the gold dollar. This will withdraw gold from circulation here; and gradually all our gold—about $659,000,000 in coin and bullion—will cross the Atlantic to pay our foreign obligations that are redeemable only in that metal.

"The withdrawal of our gold coin (aggregating $620,000,000) now in circulation would shrink our currency to the extent of one-third. This disturbance of our financial system would be rendered the more appalling by the immediate shrinkage in the value of our silver coin to one-half of its present purchasing power. The financial stringency of 1893 would be reproduced on a gigantic scale. Depositors in banks would demand the payment of their deposits in gold. Runs on these institutions would cause fifty per cent. of them to close their doors. Notes could not be discounted, and employers doing business on a credit basis would fail. Workingmen would be thrown out of employment. Rates of interest would go up as the general ability to endure the burden declined. Crash and panic—each producing the other—would be the continuous order of the hour.

"This state of affairs would be the first calamity to fall on American labor from the free and unlimited coinage of silver at the ratio of sixteen to one. The long train of consequent and subsequent evils almost defies description."

Carrying out this argument further, it is noted that wages never rise in the proportion that value of money decreases. This was proved during the late civil war in the United States. The price of labor is also one of the last things to advance, while the prices of necessaries of life are among the first to rise during a period of depreciated currency. When an employer has the opportunity to pay in one of two kinds of money, one of which is the poorer, he follows the universal rule; he pays out the inferior money. When labor receives its pay at the end of the day, week, or month, the laborer is, to the extent of his earnings, a creditor, and the employer is his debtor. If, therefore, a money system that is to favor the debtor class at the expense of creditors be adopted, it is plain that laborers must suffer in common with the class to which they belong. Labor has now the right to demand that its wages shall be paid in as good money as anybody gets at home or abroad. Why should it relinquish its right? Bimetallism, attempted by any single country, means disaster to the country that attempts it. It is a system that can be successfully carried out only by the combined action of the nations which control the bulk of the world's commerce.

The Commercial Federation of the British Empire.

THE proceedings of the congress of the chambers of commerce held in London in the second week of June are interesting and important, not only as they relate to the future of British trade and industry, but because the measures proposed, if carried out, will ultimately influence the commerce of the entire world. Among the most noteworthy of the propositions brought before the congress was one looking to the formation of a great Britannic commercial federation, including the mother country and the colonies. The British secretary of State for the colonies delivered an address favoring the formation of such a federation on the basis of a zollverein.

The Statist (London) recently offered a prize of one thousand guineas for the best scheme of an imperial customs union. One of the competitors was Mr. J. Stephen Jeans. *The Iron and Coal Trades Review* (June 12) prints an excerpt from Mr. Jeans's scheme, as of interest in connection with the current discussion of the subject.

Having become satisfied that the ordinary bases of a commercial union—"absolute free trade between the different parts of the empire, or a system of reciprocity founded on a system of differential tariff duties"—is not immediately practicable, the author thinks success may be attained upon the basis of "reciprocal arrangements which shall involve the ultimate assimilation of the customs tariffs of the colonies to that of the mother country, on the one hand, and the adoption by the mother country of new and increased obligations towards the colonies, on the other"; and to this end he proposes "a modified system of bounties and rebates . . recognized in international relations as permissible arrangements between component parts of the same empire," and which do not have the "offensive and hostile complexion presented to the outside world by discriminating duties."

It is thought that a common economic system founded on that of the mother country could thus be brought about, and that, if certain principles—of which a brief summary is herewith given—are observed, the colonies need lose nothing of immediate revenue, or in future industrial progress, as a consequence. These principles (which are deemed to accord with the advantage of the empire rather than with that of individual colonies) are as follows:

(*a*) Colonial representation, either in the imperial parliament, or in a national federal council instituted for the purpose of carrying out the objects of the imperial federation, on the basis of trade, as ascertained by the volume of exports and imports, — the council to be specially charged with the duty of examining the economic conditions and requirements of each dependency, and determining the "special resources, fiscal necessities, and industrial possibilities of each, and empowered to provide for the creation of customs tariffs for both local and imperial revenue."

(*b*) That the policy of imposing duties on luxuries followed in the mother country should be adopted, and, where such duties fail to yield sufficient revenue, the difference should be made up by "the rest of the affiliated possessions."

(*c*) Bounties to individual colonies for the encouragement of special industries approved by the federal council.

(*d*) Exemption throughout the empire of raw materials of industry from tariff duty.

(*e*) A gradual reduction of duties "in accordance with a differential scale, graduated in accordance to the amount of duty, until, at the end of not more than twenty years, they are entirely got rid of, looking to the ultimate adoption of a tariff for revenue only"; the federal council to be empowered to consider claims of any of the colonies that this action is prejudicial to their interests, with a view to modifying it, or making compensation for such prejudice.

(*f*) In return for colonial concessions, the imperial parliament, or the federal council, or both, to guarantee payment of interest on colonial railway investments under proper safeguards, and to assist the colonies in carrying out needful public works.

(*g*) Free carriage to the sea of agricultural products for export to the mother country, in competition with similar products from other countries, thus enabling the agricultural interests to compete with foreign producers on more favorable terms; and, further, if this does not sufficiently encourage these interests, the subsidization of vessels transporting agricultural products.

(*h*) Inquiry into and redress of any existing disadvantages which exports to colonies from the mother country sustain with relation to similar exports from other countries, such inquiry to be made by experts residing in the principal centers of colonial commerce, and required to report at frequent intervals.

(*i*) The establishment of commercial museums throughout the empire, and the creation of "special exchanges erected and maintained for reciprocal dealings in British and colonial produce only."

(*j*) Consolidation of the debts of the empire, resulting in reduction of interest upon colonial loans.

(*k*) Establishment of the currency of the empire upon a gold basis.

It is maintained by Mr. Jeans that the adoption of this scheme would result in an immediate great extension of colonial railway mileage, while, at the same time, it would not entail any rapid departure from the present system of the colonies; and railway extension is their present most imperative need. It is also maintained that an important merit of the scheme is the avoidance of "the apparently impossible condition of resumption of protection in the mother country, and the almost equally impossible condition of adopting a permanent system of discriminating duties against foreign countries." But we fail to see wherein bounties and subsidies essentially differ in principle from protective tariffs, or why subsidizing ships to carry products that could otherwise be obtained more cheaply from other countries is not, in every essential, a discrimination against those countries. Both subsidies and bounties are radical departures from the principles of free trade, and no ingenuity in argument or plausibility of statement can make them appear otherwise to a logical mind. The countries whose competition is dreaded are not likely to be much pleased with the avoidance of the name of "discriminating duties," when a policy of discrimination as severe and rigid as that proposed shall have been put into operation. Yet it seems highly probable that in the near future measures entirely incompatible with the doctrines of free trade will be adopted by the British people.

A Unique Boycott.

IN a labor contest in Milwaukee, which began in a strike of the employees of the Milwaukee Electric Railway and Light Company early in May on the usual disagreements about wages and hours of service, the company refused to concede the demands of the men, and turned the tables by ordering a lockout of all the old force, while filling their places with new men. But, having succeeded in obtaining new men, the company is paying their wages and running the cars, without any return for the outlay, as the citizens of Milwaukee positively refuse to ride in the cars. This course, its cause, and its sequence, are described in *Iron Age* of May 28, as follows:

"Everybody except the locked-out motormen, conductors, and electricians admit that the strike is over, for the company are running their full complement of cars on schedule time. But the original issue, important at the time, has been lost sight of and swallowed up by subsequent events which have proven of far greater magnitude than the original proceedings. The peculiarity of the case is that, while the company are running their cars night and day, practically nobody rides in them, although a pretext only is made of collecting fares, and the town is said to be flooded with complimentary tickets.

"But people do not walk. They ride in 'buses run by the local union of street-railway employees, a line of these conveyances running parallel with every street-car route in town. The union started its opposition on the principal streets soon after the trouble first broke out, issuing a manifesto to the public requesting the people not to patronize street cars pending a settlement of the difficulty. A most peculiar phase of the situation is the unanimity with which the public has observed this request. It submits to delays, joltings, and all manner of inconveniences rather than turn the nimble nickels into the coffers of the much-hated car company."

It is said that this curious state of affairs is not the result of sympathy with the strikers, but of a long-standing enmity to the road caused by the operation of a law under which the company is enabled to avoid payment of its proper share of taxation. *Iron Age* says:

"A Milwaukeean's one object in life at the present time is to keep people off the street cars. A man will not only refrain from riding on the tabooed conveyances, but he carefully watches his acquaintances and puts them 'on the list,' if he catches them. In working out this unique and remarkable boycott there is no known or admitted system, and yet by a sort of natural process the thing has developed into a system which is a marvel of perfection."

Commercial Tour to South America.

THE NATIONAL ASSOCIATION OF MANUFACTURERS of the United States has planned for the summer of this year a commercial tour to South America. The circular containing the programme arrived too late for notice in our last number; but, as the tourists have been selected and invited by the committee with reference to their representative character in the industries of the United States, the details of the expedition are of less importance than its aim and the possibilities and probabilities of its success in effecting its object, which is announced as "a practical step toward the establishment of more intimate trade relations between the United States and the most important South

American nations." The party is to visit the Argentine Republic, the Republic of Uruguay, and the United States of Brazil.

The encouragement and welcome proffered from the countries to be visited are expressed in the most cordial terms in the official correspondence appended to the circular.

"The idea of this South American trip originated in the United States legation at Buenos Ayres, and was first suggested to the Argentine government. There was a prompt response, and a cordial assurance that every courtesy would be extended to such a party of representative Americans, and that every facility for observation and investigation would be placed at their disposal. The Uruguayan government, at Montevideo, and the Brazilian government, at Rio de Janeiro, were addressed in like manner through United States Ministers Stuart and Thompson, respectively, and they responded in similar terms of cordial invitation. The invitations . . . were transmitted through the department of State and for delivery to those interested, or for such use as might be deemed advisable; Secretary Olney placed them in the hands of Mr. George W. Fishback, United States secretary of legation at Buenos Ayres, now on leave of absence in the United States. Realizing the importance of this opportunity, and appreciating the far-reaching influence such a trip would exert upon the trade of the United States with Latin-American countries, the National Association of Manufacturers undertook, in acceptance of these invitations, to organize a suitable party representative of American interests, and to carry the tour to a successful conclusion."

The president of the association is Mr. Theodore C. Search. A bureau of publicity has been established at No. 1748 North Fourth street, Philadelphia, whence circulars of information are issued. These circulars are gratuitously distributed, the one announcing the tour above named being the fifth. The general purpose of the circulars is to make known the character and progress of the work of the association (which, we think, is likely to exert a profound influence upon American commerce) and to furnish valuable information to manufacturers. So far, the methods and action of this young organization indicate that it is under the direction of able and far-sighted men.

Osaka the Manchester of the Far East.

WHETHER, as some think, the Japanese are a race of imitators, or, as some fear, they will become a race of originators, the future must decide; but, if ranked as only imitators, it must be admitted that they are extremely good ones. That which they imitate is the best of its kind, and their selections of machinery, appliances, and industries from the existing stock of the civilized world exhibit a power of discrimination which proves the Japanese mind to be of a high order.

From time to time glimpses of the extraordinary progress that commerce and industry are making in Japan are given in the daily press; but so many important things are constantly occurring nearer home that few people in the western hemisphere give much attention to what is said about this progress. That it is already a factor in the commerce of the world to which older nations can not long afford to be indifferent there are many indications.

The British Trade Journal for June prints an account of the industries of Osaka, from a letter of a correspondent of the *Adelaide* (Australia) *Observer*. This correspondent, writing directly from Osaka, is so impressed with the variety and vitality of the industries of the city that he calls it "the Manchester of the Far East."

Some idea of the magnitude of the manufacturing industry of Osaka will be formed when it is known that there are scores of factories with a capital of over 50,000 yen and under, more than 30 each with a capital of over 100,000 yen,* four with more than 1,000,000 yen, and one with 2,000,000 yen. These include silk, wool, cotton, hemp, jute, spinning and weaving, carpets, matches, paper, leather, glass, bricks, cement, cutlery, furniture,

* One yen = about one American gold dollar.

umbrellas, tea, sugar, iron, copper, brass, saké, soap, brushes, combs, fancy-ware, etc. It is, in fact, a great hive of activity and enterprise, in which the imitative genius and the unflagging pertinacity of the Japanese have set themselves to equal, and, if possible, excel, the workers and artisans of the old civilized nations of the west.

There are ten cotton mills running in Osaka, the combined capital of which is about $9,000,000 in gold, all fitted up with the latest machinery, and completely lighted by electricity. They are all under Japanese management, and, it is said, all paying handsome dividends,—some as much as eighteen per cent. on the invested capital. Out of $19,000,000 worth of cotton imported into Japan in 1894, the mills of Kobé and Osaka took and worked up about seventy-nine per cent.

As Japan is not, and never can be, a sheep country, it must import the wool needed for its manufactures. America, Europe, and Australia are the sources of its wool supply. There is only one woolen mill in Osaka. It produces thick flannels with colored patterns, and employs five hundred girls and women; but an extension of woolen manufacture is contemplated, which will equal, or perhaps exceed, the cotton industry in importance. A large increase of demand for Australian wool is, therefore, expected. The manufacture of wool carpets is about to be commenced. Cotton and jute carpets and rugs are already made in Osaka in large quantities. Osaka also contains the mint which coins the money of the empire.

One of the most notable characteristics of the Japanese is intensity of application. Be he student, merchant, artisan, or worker, it is all the same; work is deemed the natural condition, not a hardship of life. No idle class and no industrial strife as yet exist in Japan.

The British Commercial Congress.

THE significance of the proceedings of the congress of chambers of commerce of the British empire, held in London in the second week of June, is apparent to all careful observers of current events. Rising far above all other topics in importance, the feasibility of forming a grand commercial federation which will include all the British possessions was the subject most thoroughly considered and most earnestly debated. The colonial secretary, Mr. Chamberlain, in speaking to this question, declared that there were only three lines upon which, in the nature of things, such a federation could be brought about, or upon which suggestions of a scheme for it could be framed. The proposal that the colonies should abandon their present fiscal systems for a system of free trade is one of these lines. The abandonment of free trade by the mother country in favor of the colonial systems is another. The creation of a British zollverein, as proposed by the Toronto board of trade, is a third, and this the secretary thought the only line upon which any progress could be made.

The features of the Toronto scheme are the establishment of practical free trade throughout the empire, without restrictions upon the contracting parties affecting their arrangements with regard to foreign goods, with the single exception that moderate duties on articles of large production in the colonies shall be imposed by the imperial government. Without going into details, Mr. Chamberlain expressed the view that the Toronto scheme had in it the germs of a successful federation, and he thought that a proposal coming from the colonies to enter into such a federation would not be refused. However, no definite conclusion was reached, beyond the passage of a resolution expressing the opinion that prompt and careful consideration of the establishment of closer commercial relations between the United Kingdom and its colonies should be given by the home government.

The debate and the action taken indicate in the plainest manner that the idea of such a federation has taken a strong hold upon the English mind, and it is not likely to be dropped. Should a scheme of this kind be carried out, it would have a profound effect not only upon English and colonial commerce, but upon the commerce of the entire civilized world.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Industrial Sociology in the American, English, and British Colonial Magazines, Reviews and Engineering Journals—See Introductory.

*6503. The Cause and Remedy for Business Depression. Edward Atkinson (Showing that hard times result from tampering with the standard of value, and that the way out is to restore the credit of the monetary unit). Eng Mag-July. 4500 w.

*6509. Japan's Invasion of the Commercial World. Allen Ripley Foote (Showing that the inferiority of imitation to invention, as well as other causes, must disable the oriental nations for serious competition with the United States). Eng Mag-July. 3700 w.

6637. The Influence of Manufactures on Wealth and Popular Intelligence (Extract from an address of Governor Lippett, of Rhode Island, showing the importance of manufactures to a community). Mfrs Rec-June 19. 1500 w.

6638. What Is Most Needed to Bring About Greater Prosperity for the General Industrial Interests of the Entire Country? (Replies to the question from Courtenay De Kalb, and L. Warfield). Mfrs Rec-June 19. 3800 w.

*6704. The Commercial Federation of the British Empire. J. Stephen Jeans (The lines upon which such a federation ought to be formed are indicated in nineteen distinct propositions which are ably supported in an elaborate argument). Ir & Coal Trds Rev-June 12. 3500 w.

6730.—$1. Some Observations on Railroad Pooling, and the Conditions upon which Pooling Contracts Should Be Authorized by Law. M. A. Knapp (The author sets forth reasons for the belief that the interests of the public would be promoted by allowing rival railroads to substitute,—under certain restrictions,—coöperative for competitive methods). An Am Acad-July. 6500 w.

*6734. The Import Trade of Japan (The trade is said to be confined to the supply of government requirements and of railway, shipping and joint stock companies with materials. Methods pursued and peculiarities of each of these classes of import trade are briefly described). Bd of Tr Jour-June. 2000 w.

*6735. The Industries of Osaka and Competition with Australian Products. (This town is described as the "Manchester of the Far East." the largest and most important commercial city in Japan. Its commercial resources and relations are interesting topics). Bd of Tr Jour-June. 1900 w.

*6736 Commercial Treaty between Germany and Japan. (Full details of the treaty with list of articles and *ad valorem* rates of duty comprised in the treaty). Bd of Tr Jour-June. 1400 w.

*6737 New Customs Tariff of Mauritius. (Complete list of articles with rates of duties now levied). Bd of Tr Jour-June. 1500 w.

*6738. Tariff Changes and Customs Regulations. (Russia; Sweden; Germany; Belgium; Spain; Roumania; Turkey; Egypt; United States; Nicaragua; United States of Colombia; British India, and Jamaica). Bd of Tr Jour-June. 7000 w.

†6812. Sound Money the Safeguard of Labor. Rowland B. Mahany. (An argument against the proposition that "gold is the money of the bankers and silver is the money of the people"). N Am Rev-July. 1100 w.

†6813. The Necessity of Limiting Railway Competition H. T. Newcomb. (While credit is given to the interstate commerce law for much good during the nine years it has been in force, it is thought that the effect of preventing railroads from mitigating by agreement the force of competition for traffic, was unanticipated and is undesirable. An argument for legislation to remove this disability, follows). N Am Rev-July. 1800 w.

†6832 Sociology in Ethical Education. Byron C. Mathews (Our schools are considered as responsible in a considerable degree, for existing social discontent through their lack of ethical instruction, and the want of attention to the inculcation of sound principles of social relations). Pop Sci M-July. 3500 w.

6834. The Apprenticeship System under Modern Conditions (System employed in shops of the Brown and Sharpe Company). Sci Am-July 4. 800 w.

*6858. French Labor Question. H. K. Landis (Description of labor system in the works of the Société J. & A. Pavin de Lafarge). Gunton's Mag-July. 2500 w.

*6859. State Ownership of Railroads. Frank L. McVey (Such an investment is shown to involve an investment three times greater than the cost of our late civil war; that the principle involved embraces equally government ownership of mines, factories, and other large industries; that the burden of all losses would fall upon the public; that the interest on the investment at 6%, would be at least $600,000,000, that it would add 800,000 to the number of government employés, and that it is an utterly impracticable scheme). Gunton's Mag-July. 3600 w.

6892. The Municipal Ownership of Gas and Electric Plants. T. B. Fersse (An argument favoring municipal ownership). Pro Age-July 1. 7000 w.

6894. Municipal Advantages—How to Obtain Them Allen R. Foote (An argument against municipal ownership). Pro Age-July 1. 7500 w.

†6919. A Unique Strike and Boycott, with Its Results and Lessons. C. B. Fairchild (Full account, from its initiation to its close, of the strike of the employés of the Milwaukee Electric Railway and Light Company, and the boycott that followed). St Ry Jour-July. 3500 w.

MARINE ENGINEERING

The German Navy.

THE summer meeting of the thirty-seventh session of the Institution of Naval Architects, held in June, was an occasion for the presentation of many able papers, among which were two that any intelligent layman may read with interest and pleasure. No previous knowledge of the technicalities of naval architecture or of marine construction, beyond such as may be assumed for any fairly-educated man, will be needed in their perusal. The paper, "Development in Design and Construction of German Men of War," by Herr A. Dietrich, constructor-in-chief of the imperial German navy, and another, "Shipbuilding in Germany," by Mr. C. Ferd. Laeiz, the first dealing with the military, and the second with the merchant marine of the German empire, are the papers referred to.

The first-named of these papers contains the frank acknowledgment that England has been the instructor of Germany in the art of shipbuilding,—hulls, engines, and boilers. The first German ironclad, the turret ship Grosser Kurfürst, was begun in 1869 at the yet unfinished Wilhelmshaven dockyard. Recounting the progress made since that period, with mention of ships which have been built, the author said:

"A special feature in the German navy has always been the 'avisos,' speedy vessels of small fighting capacity, designed only to serve as scouts for the fleet. But soon these vessels were required to fight, especially after the introduction of the torpedo; in consequence, the vital parts had to be protected. Out of the last German vessel of any size built abroad, by the Thames Ironworks, 1875–76,—*viz.*, the Zieten,—the modern German 'avisos' were developed. These were, first of all, the Blitz and Pfeil, with under-water torpedo armament and of 16 knots' speed, forerunners of the later-built English boats, Surprise and Alacrity. The Greif, of 19 knots' speed, succeeded in 1885, and was followed by the Wacht and Jagd, of 19½ knots' speed, and fitted with a protective deck. After these come two small 'avisos' of the same speed, the Meteor and Comet, of 1,000 tons, and then the 'avisos' Hohenzollern, a splendid vessel fitted out as an imperial yacht, with 21.5 knots' speed, of about 4,000 tons displacement. The last of the 'avisos' is the Hela, of 2,000 tons displacement, now beginning her trials."

The torpedo division boats and torpedo boats are passed by the author with a mere mention as part of the German naval outfit. A table of data pertaining to five German warships now in course of construction is presented, but a clear statement of differences between German and English warships is of more general interest.

"The armor-clads, armored cruisers, and protected cruisers are divided into as many water-tight compartments as was deemed possible without interfering with the working of the vessel. Perhaps this is carried out already too far, and the service on board may be obstructed. The paper of Lord Charles Beresford, read before the meeting of the Institution in March of this year, mentions those considerations which prompted the constructor here to carry every athwartship bulkhead above the water-line, without any door in it. Any door may be left open; therefore one has to accept the probability that it will be left open; and, consequently, it is better to have no door at all. Communication from one engine-room to the other, from one stokehold to the other, must be established only over the protective deck, above water, or may be carried on below by telegraphs and speaking-tubes. Only in the athwartship bulkheads, which are beneath the protective under-water deck of citadel ships, or in the foremost and aftermost parts of protected cruisers, doors are permitted. This circumstance speaks strongly against the construction of such vessels. The abovementioned principle is strictly adhered to in all new German navy vessels. It is difficult to ventilate a ship divided in this way. Air from above must directly lead into, and out of, each compartment between two athwartship bulkheads, which has direct access from above. Only for the forward and aft compartments underneath the protective under-water decks air-ducts are carried through the athwartship bulkheads, and water-tight shutters have to be provided for, which are perhaps insufficient, but have to be made use of in vessels of the citadel type.

"Modern vessels suffer a great deal from the heat which radiates from the steam piping belonging to the large number of auxiliary engines installed in all parts of the ship, and which supplies the ship with continuous steam heating. All attempts of engineers to cover these pipes with non-conducting materials, and to insulate them so as to prevent their radiating heat, have entirely failed, and every room through which a steam pipe is carried is heated very disagreeably. The best method of counteracting these effects of steam engines and steam pipes was found to be by omitting them, and by employing electricity, the conducting wire taking the place of the steam pipe. Only by driving the many fans made necessary for the water-tight compartments by electricity is the division into so many compartments rendered at all possible. All new German warships in course of construction have electricity as motive power, not only for those ventilating fans, but also for the turning gear of gun-turrets, for ammunition hoists, for boat-hoisting, and coaling winches, and such like gear. For the turning gear and ammunition lifts of the heavy guns, hydraulic power has been retained, and steam is still used for the steering gear where it was especially difficult to install the electric motor, as well as for the anchor windlasses, which are only comparatively seldom used. Only one vessel in the German navy, the nearly finished Aegir, is experimentally fitted throughout with electric appliances, even for steering gear and windlasses. The results of these experimental installations will decide if, in the future, electricity can be used more extensively for motive power on board ships, and if the heat sources can be further dispensed with."

Among other differences named is the division of motive power. More auxiliary machinery is used, requiring a greater number of attendants. Steel-plate decks, some covered with linoleum and others with cork, have replaced wooden decks. Restricted use of wood in the construction of hulls has been practised for the purpose of lightening hulls. Interesting innovations in furniture, involving the use of steel and aluminum, have been abandoned, such furniture having been found less satisfactory than wood furniture. The beds, however, are of iron, steel, or brass.

The question as to the rival claims of water-tube boilers remains unsettled, and is regarded as one which can be settled only by experience. But the author quotes with approval the proposition laid down by a writer in the (London) *Daily News:* "In the next war the side which has the best boilers will win."

The Future of Nantes as a Port.

A RECENT report of the United States consul at Nantes, France, speaks of the increased marine traffic at that port, and thinks this is to become one of the principal French ports. The maritime canal of the lower Loire is the cause of this impulse, which has taken place in spite of the general depression in French commerce. We have condensed from the report the following particulars relating to the canal, which takes the place for heavy navigation of that section of the river comprised between the extremity of the dykes —*à la Martiniere*—and Paimbœuf, in which are the highest banks and the most difficult channels to keep open. Work was commenced on the canal in 1882, and on September 1, 1892, it was delivered over to navigation, and completed the following year.

The canal proper is 9 miles 635 yards in length, and is closed at each end by locks 328 feet long, 122 feet wide, and with an entrance of 59 feet width. Close to each of these locks there is a basin 1,148 feet 4 inches long by 492 feet 1½ inches wide, which permits the waiting and passing of vessels.

The width at water level is 180 feet, and at the bottom or floor 90 feet. At points one-third of the distance from each end there are docks for the passage of meeting vessels. On each side of the canal there is a towpath of broken and roller-pressed stone, and also numerous stocks for embarking or disembarking agricultural produce or animals. The draught of vessels passing through the canal is constantly increasing, and, although in its normal state the canal is supposed to furnish largely 19 feet 8¼ inches of depth, a vessel drawing 21 feet 1¾ inches has successfully passed, and with the aid of water drawn from the feeder—*l'achenean*—the level can be raised so as to permit during full tide the passage of a vessel drawing 24 feet 6 inches.

The number and tonnage of vessels passing through the canal have constantly increased from its opening to the present time. In 1892—four months—the figures were 123 vessels and 39,000 tons; in 1893, 595 vessels and 206,313 tons; in 1895, 791 vessels and 334,500 tons. The average tonnage has risen from 325 tons in 1892 to 423 tons in 1895.

The channel between Le Pellerin and Nantes is less satisfactory, although it has been improved by dredging, having been deepened nearly four feet since 1893.

It was easier than at first anticipated to obtain a depth of 18 feet at low tide and still water, but it has been more difficult to maintain this result at all times of the year and under all circumstances. The means at disposal of the engineers have proved insufficient to remove promptly the sand bars formed by floods or ice, an example being the closing of the river for navigation through ice for nearly a fortnight in February, 1895. After the breaking up of the ice the channel was inaccessible to vessels drawing more than 16 feet of water, for several days, owing to defective dredging. This proved a salutary lesson, as the chamber of commerce of Nantes, in conjunction with the ministry of public works, took steps to procure at once the appliances necessary to keep the channel always open with a 20 feet draught of water.

Skilled and Unskilled Marine Labor.

IN the *Yale Scientific Monthly* (June) Mr. Henry S. Pickands draws attention to the fact that on sea as well as on land the effect of mechanical improvement upon the status of labor is making itself felt. Ships now use many machines and mechanical appliances unknown to a past generation. A certain degree of skill, required for the use of these improvements, has differentiated crews into skilled and unskilled men, which differentiation has already differentiated the wages of the two classes thus evolved, and will still further differentiate them. The unskilled do and will include men who require little intelligence, but great physical endurance,—coal-passers, deck-hands, etc. The other class does and will include men of some education, judgment matured by experience, and mechanical training, ranging from the first-grade engineer down to the oiler. Marine machinery now comprises, in many cases, electric lighting, refrigerating, and ice-making machinery, etc., so that the upper grade of the engineering staff must now include men of much wider knowledge and greater mechanical skill than was necessary twenty years ago for the competent supervision of the propelling engines, pumps, and hoisting machinery,—to say nothing of the increased skill and knowledge needed to run a modern triple- or quadruple expansion engine, as compared with the marine engines of the last generation. While this change in the character of the men has been slowly evolving, a fully corresponding change in the status of the skilled part of the crew has not yet been made. The skilled engineer is yet too much under the domination of officers unskilled in engineering, and is too often compelled to do what his better judgment condemns. This state of things can hardly be avoided, until the superior officers of the ship shall be selected from the grade of chief engineer, making the line of promotion continuous from bottom to top. If this ever comes to be, the superior officers will themselves be past engineers of a high order of skill, taking the responsibility that should always accompany authority, and which should not be imposed without authority; and the engineer's duties on board ship will be relieved of many needless cares and embarrassments.

Explosions of Water-Tube Boilers.

THE fact that explosions in this class of boilers are more frequent than they were formerly indicates that in some of them a departure from sound mechanical principles has been made. It is not a sufficient answer that, as higher steam pressures are used, the liability to explosions has increased. This might account for leaks, or the rupture of single tubes; but the fact is that in this type of boilers some of the accidents that have occurred have been so general in their effects upon the boilers themselves and in their destruction of adjacent life and property that they are, and ought to be, called explosions.

The Practical Engineer (June 26) describes such an explosion on board the French ironclad "Jaureguiberry," one of the finest and latest additions to the French navy.

"The steam on this vessel is furnished by twenty-four water-tube boilers of the Lagrafel-D'Allest type. The vessel had gone for a twenty-four hours' trial trip off Toulon on June 9. Up to the twentieth hour everything went on satisfactorily, and then, without any warning, an explosion occurred in one of the boilers, which blew open the furnace doors and sent a rush of steam and flame into one of the stokeholds, so severely scalding nine stokers who were in it at the time that six died within a few hours.

"After the disaster it was found that one of the tubes had drawn from the front tube plate and burst, in addition to which a large number of the other tubes were drawn and bent. Why the tubes should have failed in this way is not satisfactorily explained. The fact, however, that one of these water-tube boilers should have given out the first day on raising steam, with such disastrous results, reveals uncomfortable possibilities to those who have so strongly advocated water-tube boilers for use in the British navy."

This will prove a damaging blow to the commercial exploitation of the type of boiler named, which rival interests will not fail to make the most of.

It is worth while to enquire whether the safety that has been claimed for water-tube boilers has not depended much upon the conditions of their use prior to their adoption for marine purposes.

As stationary boilers on land, they are usually provided with ample space, with egress for attendants on the same level, in wide contrast to the limited room that can be allowed for them on board ship. The escape of attendants is thus rendered more easy and probable, should a local rupture occur, than it ever can be on board ship, where escape from a stokehold usually means the climbing of stairways or ladders.

But the condition of the boiler above referred to shows that there was a more extensive wreck than the mere rupture of a single tube permitting a gradual efflux of steam.

The precise cause for the occurrence has not been explained; but it is evident that, if the boiler is of a character that permits the rupture of one tube to do all the mischief stated, its construction involves wrong principles, and it is an unsafe steam generator for marine service. Instead of independence, there must be some sort of mutual interdependence of the tubes that renders the rupture of one of them the cause for the effects produced upon the others. The anxiety to make the weight of water-tube boilers a minimum, and to increase the rapidity of their action when fired, has, we believe, led to ignoring points essential to safety and durability, not in this particular construction alone, but in other water-tube boilers that have claimed to be superior to fire-tube boilers for use on ships.

This sort of thing is as liable to occur on a warship in action as at any other time, and it might well determine the issue of a naval encounter. Clearly, we are not at the end of developments in the attempt to substitute this new system for the old one, which, though not free from faults, has a record for reliability in service that water-tube boilers, as a class, will be long in acquiring.

UNDETERRED, apparently, by the movement in Congress to have steam yachts which are built outside the States debarred from flying the Stars and Stripes, and from sharing in the privileges and exemptions which that distinction confers, Mr. Robert Goelet, of New York, brother of Mr. Ogden Goelet, for whom a similar yacht is at present well under way in the yard of Messrs. J. and G. Thomson, Clydebank, says *The Engineer* (London), has just commissioned that firm to build him a twin-screw steam yacht of 1750 tons yacht measurement. Like his brother's vessel, the later boat will be most sumptuously fitted, and will be propelled by triple-expansion engines, capable of giving a speed of 18 knots.

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Current Leading Articles on Marine Engineering in the American, English and British Colonial Marine and Engineering Journals—See Introductory.

*6553. The Design of Warships (Editorial review of correspondence upon this subject chiefly that which has appeared in its columns with the signature "Argus"). Engng–June 5. 3800 w.

*6599. Auxiliary Naval Machinery. Henry S. Pickands (Illustrated description of a steering device, and of a search light, with general discussion of the effect upon crews, resulting from use of auxiliary marine machinery). Yale Sci M–June. 1800 w.

6679. Breakdown of the "Merida's" Engines (Illustrated description of one of the most complete wreckages of a marine engine on record). Eng–June 20. 1000 w.

*6696. Our New Cruisers (Illustrated description of the new English cruisers "Niobe," "Doris" and "Powerful"). Engng–June 12. Serial. 1st part. 3300 w.

*6699. Development in Design and Construction of German Men-of-War. A. Deitrich (Read at meeting of Inst. of Naval Architects. The history of the present German navy and the difficulty of producing vessels rivalling those of England and France in German dock-yards and with German materials, are narrated in this paper. It is illustrated by diagrams showing the lines of three important German ships). Eng, Lond–June 12. 4000 w.

*6700. Thames Paddle Steamer Southend Belle (Illustrated general description). Eng, Lond–June 12. 1500 w.

*6701. Shipbuilding in Germany. C. Ferd. Laeisz (Read at meeting of the Inst. of Naval Architects. Brief survey of the development of the industry). Eng, Lond–June 12. 2100 w.

*6703. The Maritime Position and the Principal Features of the Port of Hamburg. Franz Andreas Meyer (Read at the meeting of Inst. of Naval Architects An eloquent and interesting description of this important port). Eng, Lond–June 12. 4000 w.

6751. The New Double-Deck-Turret Battleship Kearsarge (Illustrated description). Sci Am–June 27. 1300 w.

6753. Four-Masted Steel Schooner Honolulu (Illustrated description). Am Ship–June 25. 800 w.

*6778. Recent Improvements in Docks and Docking Appliances (Preliminary remarks upon the ideal requirements of docks and docking appliances. A statement of how far they have hitherto been met and an illustrated description of the new dock for the port of Barrow-in-Furness, claimed, in its design, to be a decided advance over other docks). Eng, Lond–June 19. Serial. 1st part. 2800 w.

*6784 The New Docks at Portsmouth (Interesting description of the harbor of Portsmouth, Eng., and of the two large new docks rapidly approaching completion, and which will accommodate the largest English warships). Trans–June 19. 4200 w.

6833. Oil Engine Signaling Plant on United States Lightship No. 42 (Illustrated detailed description) Sci Am–July 4. 1600 w.

*6934 Marine Boilers, Particularly in Reference to Efficiency of Combustion and Higher Steam Pressures. (Abstract of a paper read before the North-east Coast Inst. of Engineers and Shipbuilders. Steam pressure of 250 to 280 lbs. being deemed probable in the near future, the author proceeds to discuss the points in boiler construction requiring attention, besides mere ability to withstand these pressures when adopted. Ind & Ir–June 26. 2400 w.

*6940. On Signs of Weakness in Tank Steamers. Otto Schlick (Read at meeting of Inst. of Naval Architects. An attempt to account for the symptoms of weakness in tank steamers in strakes of outside plating, and suggestions for remedying the difficulty). Eng, Lond–June 26. 1000 w.

6948. Minimizing the Effects of Collision at Sea (Extract from address delivered at General Chamber of Commerce, Hong Kong, by Rear Admiral S. Makaroff, Imperial Russian Navy. Deals with appliances for protective use, and with methods of construction designed to lessen risk of damage through collisions at sea). Eng–July 4. 1800 w.

MECHANICAL ENGINEERING

Boiler-Tube and Boiler-Setting Practice.

ALWAYS holding in high esteem the system of topical discussion now so much in vogue in engineering associations, we find that our estimate of the value of this mode of bringing out ideas, opinions, and experiences has been, if possible, heightened by the perusal of the Proceedings of the American Boiler Makers' Association for 1895, a large part of which is given to a report of such a discussion upon boiler construction and boiler-setting. It might be imagined that a free talk among members upon so trite topics could not be otherwise than dull, but such an opinion would be far from the truth. On the contrary, it was animated and interesting, and it brought out in clear light many features of present practice in boiler-construction. The first question discussed was: "Is there any advantage to be gained by beading over the ends of boiler-tubes in comparison with properly expanding them with a roller-expander?"

Mr. Farmer (chief engineer, United States navy) said that he preferred not to bead over tubes, because, if they are not beaded, they have some elasticity and life left, and can be expanded again. If a roller-expander is used in the first instance, a Prosser expander can be used when the tubes get very bad, and he believes that they hold just as well when properly rolled as when beaded. The general sense of the members present was adverse to beading, but there was some difference of opinion as to the distance that tubes should protrude. Most who took part in the discussion agreed that the part which protrudes, whether long or short, ought to be somewhat expanded.

Mr. O'Brien, in favoring this opinion, said that his reason for not bending them down was that, when a piece of iron or steel is flanged flat, the part turned in, as a general thing, is cut or broken more than half-way through.

Mr. H. S. Russell said that he had been setting tubes without beading for thirty years, with the expander coming beyond the head, so as to give a little flare to the tubes. But he had met a difficulty. If the tubes project more than one-eighth of an inch through the back head, they burn, and become brittle. If, therefore, the tubes are passed through the back head more than one-eighth of an inch, he thought they ought to be beaded; but not for strength. He had never known a tube to slip for want of beading, but he had known tubes that were not beaded to burn, so as to be practically destroyed, becoming so brittle that they would break clear into the head; in such cases they must be taken out.

Another member thought it better not to let the tubes protrude so much as one-eighth of an inch. On the contrary, Mr. Garstang advocated the protrusion of the tubes to from one-fourth to three-eighths of an inch. He had never met the trouble specified by Mr. Russell, but he did not approve beading. This last was the sense of twelve out of fifteen of those who spoke to the question.

A second question was then discussed: "Do you think there is any advantage in having one or more vertical spaces between tubes to assist circulation, in comparison with ample space between each two vertical rows of tubes?"

Upon this question the discussion was lively, bringing out such a diversity of opinion and practice that the merits of the question do not appear to have been decided in favor of one practice more than the other. In either case, if too many tubes are not put in a boiler, the circulation will be satisfactory, and removal of scale will not be difficult.

The punching of rivet-holes to a smaller diameter than needed, and the enlarging of the holes with a drill to the proper size, were strongly advocated by a majority.

There was general agreement that the depth of a flange for boiler-heads should be about six times the thickness of the plate.

There was a good deal of difference of opinion upon the subject of bridge-walls. It was generally conceded that bridge-walls are needed for the best consumption of fuel, but there was a wide divergence of opinion as to the shape of the bridge-wall and its distance from the boiler shell. On the whole, the straight bridge-wall appeared to be most favored, and Mr. Allen, of the Hartford Boiler Inspection and Insurance Company, gave as a scientific reason for this preference that a round-about bridge-wall intercepts radiant heat from the grate.

Structural Stiffness and Mechanical Flight.

THE problem of mechanical flight still commands the attention of able men. One of these, Mr. Maxim, has won fame and wealth by his achievements, and is deservedly ranked among the foremost inventors of the age. His experiments in mechanical flight have been carried out on a scale without a precedent. They show that mechanical flight is possible. The experiments of Professor Langley show the same thing. Herr Lillienthal has also succeeded in making short flights. We may admit, therefore, that the possibility of flying through the air by self-supporting mechanism is now a demonstrated fact.

What then? Is mechanical flight, for anything except some limited special service, a practicable scheme? In novels and illustrated papers the wild imagination of dreamers have been presented to the general public mind, and many have come to believe in the probability that gigantic air-ships will, at some not far distant time, carry passengers across the seas, meet in conflict in the clouds, and carry on a commerce between nations, as marine vessels now do. The mechanical engineer, however, sees the enormous gaps that lie between these imaginings and the possibilities of achievement, as they now exist; and he needs only to consider the materials available for mechanical construction to beget in him the profound conviction that the idea of transportation of passengers or freight on a commercial scale by flying-machines is entirely chimerical.

An editorial on this subject in *The Practical Engineer* (June 26) speaks of a letter recently written by Mr. Maxim to the *Times* (London), in which this eminent mechanical engineer intimates very clearly that the weight of materials as related to strength is an obstacle yet unsurmounted in the attempt to construct a flying-machine of large lifting and sustaining power.

"In the case of the small experimental apparatus which Maxim used prior to the construction of the large machine referred to, he found it possible to exert an upward lift equal to fourteen times the thrust of the driving screw,—that is to say, that, when the screw exerted a thrust of 3 pounds, he could lift $14 \times 3 = 42$ pounds. In constructing the large machine, however, 'it was,' he says, 'necessary to stay it in every direction,' in order to obtain the stiffness requisite for stability. The result of this was not only to add proportionately much greater weight, but at the same time to materially increase the frictional resistance. The consequence was that, when the machine was tried, the lifting effort, instead of being fourteen times, as in the small machine, was only five times the thrust of the screw. In other words, its efficiency for flotation was reduced to one-third, and this notwithstanding that the engines were worked to double the capacity they were originally designed for; so that, as Mr. Maxim states, 'the factor of safety was very low.'"

Commenting upon the statement of Professor Langley (approved by Mr. Maxim) that the difference in efficiency between large and small machines (resulting from the greater relative weight of structures as they increase in size) "is an unknown factor as relates to size, unfavorable to large machines," the editorial under review says: "This factor, however, is not so mysterious or unknown as Mr. Maxim and Professor Langley would appear to think. It is a recognized element in engineering design, whether relating to flying-machines, bridge roofs, or any other framed structures, and it is this recognition of the inexorable limits imposed on the size of structures by the nature of the materials available that has enabled engineers to realize the enormous difficulties that lie in the way of man's attempt to exercise that dominion over the air that he does on land.

"In the case of all motors, whether animate or inanimate, the weight increases much more rapidly than the increase of power, simply from the fact that the dimensions of the beams, cantilevers, and links of which they are, structurally speaking, composed, require to be increased at a much greater rate than the span or leverage, as the case may be. Take the case of a simple rectangular beam: as far as strength is concerned, this may be said to vary inversely as the length, but structures cannot be designed with this view alone, at least not when rigidity and permanence of form are essential factors. Other things being equal, if the length be doubled, the deflection would vary as the cube of the length; in other words, a beam of the same section with a double span, although it would be twice the weight, would have eight times the deflection. To secure the same stiffness it is almost invariably necessary to employ a much greater quantity—and therefore weight—of material than the increase of span would indicate to those unfamiliar with the laws which govern stiffness, and it is this consideration which, even with the strongest materials available, soon imposes limits on the size of bridges, roofs, etc."

The structure may be so large (for instance, the Forth bridge) that the load it is intended to support over and above its own weight is almost nothing in comparison with that weight. The mechanical structure of living beings—*e. g.*, birds—conforms to this law of limitation as surely as artificial structures. The larger birds, whose fossil remains may be seen in geological museums, did not fly. The largest known living bird, the ostrich, does not fly. His wings only assist his feet; and yet the largest birds have always been small in comparison with other contemporaneous land and marine animals. Moreover, birds of flight can stop and, so to speak, "coal up" at will. The stock of fuel which a wild duck needs for temporary use he can obtain by settling down upon any convenient stubble field. So far as known, the absence of stubble-fields in mid-sea has hitherto prevented birds whose natural habitat is the land from attempting flight across large bodies of water. So that, while we may admit mechanical flight to be a demonstrated possibility, its future general commercial practicability may well be doubted by those who do not rest opinion upon the vain imaginings of writers of fiction.

Powdered Coal as Fuel.

We have not met a better article on the subject of powdered coal for fuel, as developed in Germany, than that read by Mr. Bryan Donkin before the Federated Institution of Mining Engineers at its recent meeting, and reported in *The Colliery Guardian* (June 12).

In the course of the essay the author says that weight is not the proper standard for the purchase of coal, and that the price paid for fuel should correspond to "the quantity of heat it contains." This proposition is not expressed very scientifically. The quantity of heat developed in its combustion is evidently what the author means. But, as this can not be determined for coal or any other fuel, except by an experiment for each sample, supposed or proved to be a fair sample of the coal purchased, and as the amount of heat developed must depend upon more or less complete combustion, the suggestion seems to be impracticable in the coal trade. It is also suggested that a sliding scale should be adopted for the amount of dirt contained in coal, which varies in different samples from five to fifteen per cent. of the entire weight. This dirt produces useless and harmful clinker, which costs time and labor to remove. But, when Mr. Donkin says "it is not tons of coal, but so much heat," that boiler-owners want when they buy coal, he puts an old truth into new and forcible expression.

Powdered coal, in combining with oxygen in the act of combustion, will generate more heat than can be obtained from it in any other way, except by first converting the coal into gas, and the pulverization of coal at the cost of one shilling per ton (alleged to be the average cost) is considerably less than that of making a ton of coal gas. The reason why more heat may be obtained from powdered than from lump coal is that, with suitable appliances, a more perfect and rapid combustion can be effected. Twenty years ago or more the extensive experiments of the American engineers, Whelpley and Storer, proved this to be the case. But these experimenters were ahead of the times, and they failed to make a practical commercial success of the system.

At the present time five systems of burning powdered coal are working in Germany. The forced blast is used with some, as it was used by Whelpley and Storer. Others employ a natural draft only, with means for continuously supplying the powdered coal to the furnace for maintaining continuous combustion. Of the latter class is the Wegener system, which sifts the powder into a current of air entering by natural draft, quite uniformly, the sieve through which the fuel passes being aided in its delivery by a tapper which beats against the sieve to which the coal is supplied. This tapper is operated by an air turbine working in the duct which supplies the air, the air current being set up by heated gases passing out through a chimney stack in the ordinary way. The arrangement could scarcely be more simple. The powdered coal falls into the ascending current of air, and, thus thoroughly mixed with the supporter of combustion, passes with it into the furnace, becoming almost instantly ignited and burning with intense heat.

The sieve employed is of wire gauze, sixty meshes to the inch,—and the particles of coal are reduced, before use as fuel, to a fineness of from $\frac{1}{100}$ to $\frac{1}{1000}$ inch.

In the discussion elicited by the paper, some thought the fineness of the coal had been carried further than necessary. This was the opinion of a member who said he had been experimenting with powdered fuel; but, on general theoretical principles, the finer the dust, the more instantaneous and complete should be the combustion, so that the fineness of the coal becomes purely a question related to cost of producing the grade of fineness used, as considered with reference to the effect gained by a superior grade of fineness.

A question which might have been raised, but which does not appear either in Mr. Donkin's paper or in the discussion, is the proper method of disposing of the ashes remaining after the combustion. The dirt fuses into slag under the high temperature produced; but, in a current of air strong enough to carry along coal particles of $\frac{1}{100}$ inch fineness,—the particles of the ashes resulting being much smaller and lighter,—we should expect, without some special means of separating them from the spent gases, that they would all be carried up and out of the chimney, thus substituting a new nuisance for the old smoke nuisance, the abatement of which Mr. Donkin claims as a point much favoring the use of powdered coal as a fuel for steam generation.

Preventing Sponginess in Castings.

A GERMAN patent recently issued to Mr. Fr. Krupp so well sets forth the cause of non-homogeneous castings and the reasons for frequent failures of aluminum as a preventive that we condense from a ranslation in the *American Manufacturer* (June 12) the following clear explanation of the reactions which take place in molten metals when aluminum is added. The object of the process is to free steel, nickel steel, and other alloys, which, by reason of the manner of their production, contain oxygen, from this oxygen during casting. If not prevented, the oxygen will combine with the carbon that is always present in the casting material, forming carbon monoxid, and, as this union takes place rather slowly, there is always danger of blow-holes being caused. Until now it has been the custom to prevent this evil by adding to the liquid material during casting aluminum either pure or in combination with iron or steel, with the result that the oxygen, which chemically is more closely related to aluminum than to carbon and iron or the other metals contained in the casting material, was absorbed by aluminum by forming with it fine clay earth, which to a large proportion remained suspended in the casting.

Although the formation of blisters was prevented by this means, the clay particles still represented an impurity in the castings. Now, this impurity, too, can be removed by adding to the liquid material, instead of aluminum or its iron alloy, an alloy consisting of one or more metals of closer chemical relation to oxygen than that possessed by the metals to be cast, and one or more electro-negative, non-metallic elements or metalloids, like silicon or boron. The elements of such an alloy, if mixed in proper proportion, are transformed by absorption of oxygen into silicates, borates, etc., which produce a more or less easily fluent slag. The latter, being formed very quickly, rises in single drops to the surface of the liquid and considerably heavier casting material, and makes it perfectly pure and free from blisters.

Best suited for metallic addition will be aluminum or alkaline earth metals, like magnesium, either each metal by itself, or two or more combined, or in combination with one or more other metals, like manganese or iron, while the non-metallic flux should consist of silicon. As the single silicates do not produce as easily fluent slag as the double or multiple silicates, the use of at least two metals for flux will be advisable.

The use of alkaline metals, like potassium, sodium, etc., can hardly be thought of, although they possess the greatest chemical relation to oxygen, or rather for this reason,—because their quick and violent combination with oxygen may lead easily to explosive occurrences. Besides, their higher price is an obstacle to their adoption. Pits non-metallic addition boron is in many cases just as good and sometimes even better than silicon, because borates will volatilize at lower temperatures and evaporate out of the liquid casting as soon as formed to boracic acid gas by their combination with oxygen.

Silicon or boron may be replaced by phosphorus or a similar element, for the purpose of the non-metallic flux is solely to form, by the absorption of oxygen together with the metallic flux, easily fusible or volatile combinations, and to prevent the formation of powdery secretions.

An especially suitable addition for steel casts is an alloy of aluminum with manganese and silicon, the two latter substances in the form of ferro-manganese and ferro-silicon in the proportion of five per cent. of aluminum to ten per cent. of manganese and ten per cent. of silicon for seventy-five per cent. of iron. Even if manganese should be left out of this mixture, it is probable that a bi silicate, silicate of aluminum and iron, would be produced, but the presence of manganese will furnish a surer guarantee for the formation of an easily fluent slag.

Care of Engine Cylinders and Pistons.

In an article on this subject, Mr. E. H. Kearney in *The Safety Valve* (June) says truly that one of the most common defects is a leaky piston caused by imperfect piston packing. The attention of engine-builders has been directed earnestly to the supply of a good piston packing, and it would take some time to name all the patented and unpatented devices that have been used for this purpose. On the other hand, some prominent engine-builders make solid pistons, and rely upon grooves and excellent fitting to render them steam-tight when running. The latter are growing in favor, and for high-speed engines they entirely fill the bill. The water condensed in the grooves can not be forced out in the time of a single stroke, and therefore opposes an impassable barrier to the steam. But, with or without packing, a piston will leak, unless the cylinder be cylindrical and of uniform diameter throughout. Unequal expansion may affect the roundness of the bore, and cylinders are frequently sent out that never had a round uniform bore. Cylinders also wear out of round. Hence, when Mr. Kearney proposes to test the tightness of a piston by turning an engine onto its dead center, taking off the head at the opposite end of the cylinder, and watching at the open end for leaks, he names a common, but yet imperfect, way of testing. The method tests tightness only in the two extreme piston positions. By using a stout clamping bar, bolted to the cylinder flange, the test described may be made for any piston position. Tested in this way, it may be found that the piston, tight in one place, may leak in another, thus indicating that the cylinder is not of uniform bore.

Mr. Kearney describes the usual makeshifts for tightening ring-packing. These are good things to know, but, if proper fitting, in the first instance, has been done, and adequate care and skill have been applied in use, they will not often be needed.

Passing other practical remarks relative to counterbores, follower bolts, etc., the hint that a small quantity of good cylinder oil is of more service in cylinder lubrication than a flood of an inferior lubricant ought to have been supplemented by the statement that a uniform small supply of oil to the cylinder at short intervals is far more effective and economical than a larger quantity put in at longer intervals. A good sight-feed lubricator which supplies the oil drop by drop is the most perfect appliance yet devised for this purpose.

Remediable Losses in Belt Driving.

THE losses in transmitting power by belts are, on the average, much larger than is commonly supposed. Excess over the necessary losses is in most cases the result of faulty design and construction. Mr. M. W. Danielson has recently presented in *The Age of Steel* an estimate from four different mills, which is cited here as substantiating the statement that such losses are underestimated. He found the percentages of total power applied to shafting used in driving the belts and shafting in these mills to be respectively 22.7, 39.2, 25.6, and 23.6. Between the highest and lowest of these percentages there is a difference of 16.5 per cent. of the total power used, to be accounted for only on the supposition that the design and construction are better in one case than in the other.

There has been of late years a tendency toward using narrower belts and pulleys; but we are unable to see that any saving in friction could have been made in this way, unless the belts and pulleys previously used were of widths in excess of what was needed. Belts and pulleys should be proportioned to their work,—neither too narrow nor to wide. Excessive width means excessive weight and increased friction. If a belt is so narrow that it must be run with great tightness to do its work, this also means increased pressure on bearings and increased friction. So one may err in exactly opposite directions. We agree with Mr. Danielson that the conditions under which narrow belts and pulleys are used are seldom the right conditions, and that for general purposes narrow belts and pulleys are to be avoided.

The system of running line shafting at high speed, when proper attention is paid to lubrication, is undoubtedly economical; but this demands accurate alignment, and careful attention to constructive details. Perfect solidity in supports, perfect alignment, good oil constantly supplied to bearings, belts, and pulleys of such width that belts can do their work when running reasonably slack,—these are the great secrets of the economical transmission of power by belting.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

The Machine Shop.

6524 Molding Machines and Air Hoists. John Randol (Illustrated description of machines and processes). Am Mach-June 11. 1400 w.

6561. Transmission of Power (M. W. Danielsen (The losses due to friction in belt driving are shown to be much larger than are generally supposed, and practical suggestions for reducing them are presented). Age of St-June 13. 1600 w.

6614. Pattern Shop Costs. A. Sorge, Jr. (A method of ascertaining cost of pattern shop work, classified and in a readily comparable form, and one which also indicates the efficiency of the department. The method, though restricted in this article to wood patterns, can easily be extended to metal pattern work). Ir Age-June 18. 6000 w.

6640. Molding Bronze Tuyeres. George O. Vair (Illustrated description of flask core box mold and process). Am Mach-June 18. 700 w.

6748. Peculiar Planing. John Randol (Illustrated description of a method for finishing concave surfaces on a planer, and of a method for planing rod straps on the inside). Am Mach-June 25. 1400 w.

6786. Power of Blast Penetration and Improvements in Center Blast. Thomas D. West (Read at meeting of Western Foundrymen's Assn. Experiments with and arguments in favor of the use of the center blast in melting, with illustrated description of improvements in the method, and discussion). Ir Tr Rev-June 25. 5300 w.

6817. Setting Valves of Locomotives. Fred E. Rogers (Description of method). Am Mach-July. 1200 w.

6818. Sand-Sifting Machine. John L. Klindworth (Illustrated description). Am Mach July. 250 w.

6827. Key-Seating on the Planer. John F. McNutt (Illustrated description of method in which the cutting is done by broaching tools). Am Mach-July 2. 400 w.

6838. Modern Boiler Making Contrasted with Old Methods. Henry J. Hartley (Paper read at the convention of the Am. Boiler Mfrs.' Assn. Past and present of boiler building. Treatment wholly practical). Ir Age-July 2. 2500 w.

6840. Strength of Tubing. Oberlin Smith (The lack of data and the urgent need of more light upon this subject and agreement upon standard specifications are topics discussed). Ir Age-July 2 1000 w.

Steam Engineering.

6537. The Efficiency of Steam Boilers (Brief editorial review of papers upon this subject read before the American Society of Mechanical Engineers, at three successive meetings, of discussions upon these papers by members, and articles, letters, and discussions in technical journals elicited by them). Eng News-June 11. 1800 w.

6563. Experiments with Boiler Coverings (Experiments directed to a comparison of mica boiler covering with those of other kinds, in which mica was found superior to any other material. The experiments were carried out in the Mechanical Department of the Canadian Pacific Railway. A diagram showing graphically the results is presented). Can Eng-June. 1200 w.

6574. Direct Graphic Determination of Initial, Terminal, and Cut-off Pressures, in the Trailing Cylinders of Multi-Expansion Engines Having Fixed Cut-offs. Charles M. Jones (Full description of method with diagrams). Elec Engng-June. 2700 w.

*6602. Constants for Steam Engine Design. W. S. Goll and L. J. Gray (Account of an investigation instituted to derive from reliable data constants to be used in steam-engine design). Sib Jour of Engng-June. 1100 w.

*6604. A Study of Initial Condensation. Arthur L. Rice (An attempt to find a convenient and accurate formula expressing the probable amount of condensation at admission of steam into an engine cylinder). Sib Jour of Engng-June. 1000 w.

*6605 Engine Valve Friction. W. A. Gordau and F. H. Hazard (Experimental research with tabulated data). Sib Jour of Engng-June. 1000 w.

*6607. Initial Condensation. E. T. Adams (Experimental work upon this subject in progress at Sibley College). Sib Jour of Engng-June. 900 w.

6610. Erection of the Corliss Engine. Paul Stapanskey (Detailed description of a method whereby rapidity and rigidity in erection, together with proper alignment of parts, etc., are secured). Safety V-June. Serial. 1st part. 900 w.

6611. The Store and Office-Building Engineer. W. L. Patterson in *The Inland Engineer* (Necessary qualifications for engineers in stores and office buildings, and a criticism of the growing tendency to employ one man as chief-engineer, consulting engineer or electrical engineer for a number of places). Safety V-June. 1000 w.

6612. The Steam Pump and Water Pipes. C. A. Collett (Methods of computing flow and delivery, horse-power needed, etc). Safety V-June. 5000 w.

6613 Something about Packing. W. H. Wakeman (A practical dissertation, giving many useful hints). Safety V-June. 2800 w.

6618. The Variation of Steam Engine Economy with Change of Load. W. F. Durand (A careful study and graphic representations of the variations and causes of economy in engines working under variable load, with tabulated data). Am Elect'n-June. 2500 w.

†6657. The Temperature Entropy Diagram. G. A. Goodenough (A brief résumé of the most interesting properties of the $T\phi$ diagram in thermodynamics). Tech-May, '96. 2200 w.

*6689. Steam Engines for Direct Connected Electric Generators. E. A. Sperry (Illustrated description of a new design of an engine for direct connected electric generators). Jour Assn of Engng Socs-May. 2200 w.

*6727. Powdered Coal for Firing Steam Boilers: Wegener and Other Systems. Bryan Donkin (Read at meeting of Federated Inst. of Mining Engs., London. Combustion and air supply; analysis of gases; boiler efficiency; transmission of heat, &c. Systems of powdered coal firing now in use in Germany. Practical applications of the Wegener system to boiler firing. Description of the system and experiments therewith. Summary and discussion. A very able and thorough paper). Col Guard-June 12. 4200 w.

6830. Metallic Stuffing-Box Packing. Edwin N. Wiest (A two-ring packing, illustrated and described, with composition of alloy for such packings). Am Mach–July 2. 450 w.

6842. The Passing of the Engine Runner (The effect of large power plants upon the occupation of engine runners, the number of which is annually decreasing). Power–July. 1200 w.

6861. Mechanical Stokers (A comparison of various stokers). Bos Jour of Com-July 4. 1800 w.

*6868. The Calorific Value of Coals. E. Goutal (From the "*Revue de Chimie Industrielle.*" A method for determining the calorific value of coal thought to be of sufficient accuracy, but which does not involve the use of a calorimeter). Prac Eng-June 26. 700 w.

6898. An Interesting Power Plant (A description of an ingenious way of enlarging an old foundation for a steam engine by the use of railroad iron) Eng Rec–July 4. 800 w.

6969. A German Mechanical Stoker (Illustrated description). Eng News-July 9. 300 w.

Miscellany.

6531. The Manufacture of Coke and Its Selection for the Foundry. W. T. Rainey (Read before the Foundrymen's Assn. Abstract. The process of coking and method of charging the ovens in the Connellsville district is described, and brief reference made to another process, used a great deal in Europe). Ir Age–June 11. 1600 w.

6532. Some Interesting Piston Rods. H. K. Landis (A most interesting description of hollow piston rods that failed on the great steam hammer at Bethlehem, Pa., and of a final one of nickel steel that has stood since 1892). Ir Age–June 11. 1000 w.

6641. Some Compressed-Air Victims. Frank Richards (Past failures in air propelled street cars, and their causes). Am Mach–June 18. 1800 w.

†6670. Stresses and Deflections in Circular Rings under Various Conditions of Loading. Claude W. L. Filkins and Edwin J. Fort (A mathematical investigation with formulæ and diagrams. Previous literature of the subject is referred to). Trans Assn of Civil Engs of Cornell Univ–June, '96. 4300 w.

*6687. Metrological Standards and Gauging Implements. J. Richards (A very interesting historical sketch, presenting facts relating to grinding calipers and gauges that are not generally known). Jour Assn of Engng Socs–May. 5000 w.

*6688. Economy in Combustion and Smoke Prevention. C. F. Mabery (The subject is treated from both chemical and mechanical standpoints. Discussion). Jour Assn Engng Socs–May. 5800 w.

6708. Hydraulic Rams. Carl Pixis (Illustrated description of three varieties of a new kind of hydraulic ram, recently exhibited at the Paris Agricultural Exhibition). Eng & Min Jour–June 20. 1000 w.

*6785. The Art of Bronze Casting in Europe. George Simonds (History and hints upon the molding and casting of artistic works in bronze). Jour Soc of Arts–June 19. 13-500 w.

6853. Power for Motocycles. Leland L. Summers (A discussion of the advantages, and a comparison of results, of the gas engine, or internal combustion motor, and the electric motor). Elec Engng-July. 3400 w.

6865. Some Experiments on the Strength of Leather. Walter G. McMillan (Description and results of mechanical tests made by the Indian Ordnance Department, to determine the tensile strength of harness leather. Discussion). Leather Mfrer–July. 2800 w.

*6867. Producer Gas and Gas Producers. A. H. Sexton (The first part treats the subject from the chemical standpoint). Prac Eng–June 26. Serial. 1st part. 4500 w.

6874. Centrifugal Pumping. J. Richards (Review of progress). Eng News-July 2. 1200 w.

6876. Locomotive Counter-Balancing (From a committee report presented at the annual convention of the Am. Ry. Mas. Mech's Ass'n. Epitome of practice as collected by the committee through correspondence). Eng News–July 2. 1000 w.

6881. Improvements in Standard Machines. Payson Burleigh (The author points out that a large number of so-called improvements upon standard machines are not improvements, and that their purpose is simply to aid in sales, the machines being in many cases no better, and in some cases not so good for the additions). Age of St–July 4. 2400 w.

†6901. Utilization of the Anthracite Culm Heaps in the Production of Power. Nelson W. Perry (The vast amount of mechanical power now latent in the heaps of unutilized culm, and the feasibility of utilizing this power is the subject discussed). Jour Fr Inst–July. 6500 w.

†6928. The Invention and Development of the Masticator (A machine used for breaking down or milling crude rubber is described by the inventor, Thomas Hancock). Ind Rub Wld–July 10. 2000 w.

†6931. The Export of American Bicycles and Tires (The encouraging outlook for this industry, with table of details of bicycle exports from New York for the three months ending June 30). Ind. Rub. Wld. July 10. 1600 w.

6961. The Efficiencies of Air Compressors. C. P. Paulding (Review of some points in articles which have recently appeared in American Machinist. The possible and actual in air compressors). Am Mach–July 9. 1200 w.

6962. Wire Rope Haulage. T. E. Hughes (Read before the Ohio Inst. of Min. Engs. Practical points in the use of wire rope, in which it is asserted that a general rule as to manner of operation is impracticable, and a statement of conditions requiring special treatment is made). Min Ind & Rev–July 2. 2500 w.

6972. Safety in Locomotive Boiler Construction (Editorial explaining and discussing the differences between radial stay boilers and crown-bar boilers, with general comments). Eng News -July 9. 1200 w.

MINING & METALLURGY

A Wail From the Australian Gold Fields.

A VERY promising young gold boom in western Australia, according to some accounts, is on the verge of perishing from thirst in "a dry land where no water is." The situation is so serious, in the eyes of *The Mining Journal, Railway and Commercial Gazette*, that it devotes space in a recent issue to a breezy letter from Mr. Raymond Radcliffe, a technical report from Carl Schmeisser, and two editorials—all bearing upon the one topic.

"Water, water alone," cries Mr. Radcliffe, "means dividends," and this is to be taken in its literal and material sense, and not in that usually attached to the term in "the street."

"Indeed," he says, "so rich in reefs is west Australia that there is absolutely no demand for 'wild-cats.'" "The gold mines of west Australia are so rich that neither dear labor, nor expensive food, nor high rates of carriage can stop the progress of the country, once the water question is settled." "No man prospecting in the country need fear of finding reefs. As to whether these reefs will pay to-day is another question."

From Mr. Schmeisser's report the difficulty appears to be concentrated in the southern districts. He says: "Whilst there is, particularly in the northern and western gold fields, generally a sufficient quantity of water for milling purposes to be obtained at depths of only 70 or 80 feet, milling in the southern districts, as far north as the East Murchison gold fields, meets with the greatest difficulties on account of the universal scarcity of water in that country." And this leads Mr. Radcliffe to the sad conclusion that these wonderfully numerous and rich reefs "are simply mines which will not pay, until some good water scheme has been established. Bayley's Reward has many thousands of tons of one-ounce stone which to-day will not pay for crushing, but which would pay splendidly, if Coolgardie had as much water as they have at Charters Towers, where in the early days there was no water at all. At the 90 Mile there are literally millions of tons of quartz waiting for ample water-supply, the Caledonian Mill being only run upon the richer stone in the mines.

"At the Black Flag Proprietary there is stone enough to keep a 100 head battery going for years; but here again they will not be able to run more than 20 or 30 with their present supply. At Hannan's the water difficulty is acute. I have mentioned the 90-Mile, Black Flag, because in these places the water is more plentiful than upon any other camp in the field, except, perhaps, Menzies. But Hannan's is the field *par excellence*. Here the reefs are both wide and rich; here no one seems to make a mistake; the whole 10 miles of reefs are marvellously rich. *Cui bono?* No one can crush. The Great Boulder ekes out a splendid existence by mining the wet ore from the 200 feet level, with the drier lode taken from above the 50 feet. It runs its 10 head steadily enough, and it also runs 10 head in the Lake View when it can. It has just about enough water to keep a 20-head going. The Great Boulder is the only mine with a constant water-supply drawn from the so-called lake, which is only a salt pan with a granite bed in which the water is held.

"The Brownhill has taken its fate in both hands, and its dry-crushing plant may succeed, but it will be a bold man who prophesies success here. Lake View, with its schistose quartz mixed with kaolin limestone, will take 30,000 gallons a day to keep its 20 head going, and they have no earthly chance of getting half this amount. Ivanhoe and Iron King have just enough water to crush six months out of the twelve. Few of the other Hannan's properties can count upon more than a few thousands gallons of water a day.

"Now I ask: Can this state of affairs continue? Is it reasonable? Here we have a magnificent series of mines, 'rich beyond the dreams of avarice,' and nearly all lying idle for want of water. I say that it is not a question for private enterprise, but a national question.

"Water cannot be obtained in western Australia unless some one—either the government or a big corporation—does put down from five to ten millions. The capitalist cannot run the risk. The government must, therefore, do the thing themselves. They have no choice."

This certainly seems about as remarkable a conclusion as could well be reached from the premises which Mr. Radcliffe himself has laid down, and suggests the converse of an often-quoted proverb; perhaps those whom heaven helps too much lose the power of helping themselves.

A more startling instance of the tendencies of State Socialism could hardly be found than is here afforded by the calm assumption by the writers in *The Mining Journal* that it is the unquestioned duty of the government to step in and do anything that capital is too timid or too lazy to do for itself. They are so perfectly frank. Mr. Radcliffe says: "The reason I write this is to urge upon the London shareholders to combine to force this water question upon the government."

And all this in spite of the evidence that the advantage would not even be general. To quote Mr. Schmeisser again: "Seeing, however, how large is the area of the goldfields, and how scattered the mines are in them, it is quite natural that only the main groups of veins could participate in this advantage. The solitary and the distant mines will have to rely, then as now, upon their own water-supplies. For these it will be indispensable to employ only such processes as can work with the minimum possible consumption of water."

It is hard to share Mr. Radcliffe's concern for the owners of these miles of "marvellously rich" reefs, where "no one seems to make a mistake," who now demand that an equally beneficent protective influence shall secure for them, without any risk to themselves, all the needed necessary conditions. A sturdier type seems to be developed in countries where the government is not so confidently expected to act as a sort of supplementary Providence.

The Year's Production of Silver.

THE statistics of the world's silver production for the year 1895, as presented by *The Engineering and Mining Journal*, will be a surprise to those readers whose impressions have been formed chiefly from the daily press. The general impression that the industry was stagnant has been cultivated by both sides in the financial controversy, though their attribution of causes and their inferences have been diametrically opposed.

Curiously, too, mining and metallurgical literature has favored the same conception although quite innocently. So much interest has been excited by recent developments of gold properties that these have naturally taken the first place. Australia has succeeded the Transvaal, and, among our English contemporaries especially, has eclipsed everything else; and silver has been as subordinate in technology as it has been prominent in politics.

The figures reviewed in the *Journal*, however, correct these misapprehensions, and "put the total production of silver in the world in 1895 at 181,850,731 fine ounces (5,651,962 kilograms),—an actual increase of 3,182,630 fine ounces (97,818 kilograms) over 1894. In the United States, while there was a small decrease last year—3,515,640 ounces, the total for 1895 being 46,331,235 ounces—in the silver produced from native ores, there was a large increase in the silver smelted or refined from imported ores and bullion, and the total quantity of metal put into marketable shape in this country last year was 76,437,071 ounces, or actually 6,247,485 ounces more than the similar total for 1894. These figures show that the silver producers have not been idle, and warrant the presumption that they have not universally been working at a loss."

The data of our own mines are the most unexpected. The clamor of the silver agitators would naturally create the impression that the mines were nearly or entirely idle: instead of this, the output was only about seven per cent. short of that of the preceding year,—far from a bad record, considering the depression experienced in all lines of business and industrial venture. And the smelters, it will be noticed, made up this loss, and more besides.

It is rather remarkable that, in spite of the increase in total production, the price of silver has marked an almost unbroken advance from 59.69 cents per troy ounce in January, 1895, to 68.69 cents in June, 1896.

As to future prospects, the *Journal* says: "The production of silver is evidently not continued on hope alone, since some of our own larger mines were able not only to keep at work, but to pay dividends also, and the same thing can be said of a number of the Mexican mines. While it is entirely impossible to fix on any average of the cost of producing silver, it is evident that, for an output of, say, 45,000,000 ounces in the United States, it is at present below 65 cents an ounce.

"While no very large increase in the production of silver is probable under existing conditions, and while these have very much discouraged prospecting for and opening new mines, it is altogether likely that the present rate of production will be maintained for a time. There is, at any rate, no reason to look for a material decrease for some years to come, while the Mexican and South American mines continue to be worked at the present rate; the Broken Hill mines in Australia are arranging to increase their output by working on a large scale the sulphid ores, which have hitherto been neglected; and, finally, while the important part of the silver output which is won in connection with copper, lead, and other metals is increasing."

The Hygienic Relations of Coal Mining.

THE COLLIERY GUARDIAN has some information on the subject of mortality and health among the coal miners of Great Britain which, in its summary, is strangely contrary to the general belief.

It is safe to say that the occupation would be classed at least "extra-hazardous" by insurance companies, and, in the popular conception, the coal miner carries his life hanging by a thread,—a stick of dynamite in one hand and an open flame in the other.

It is, therefore, more than surprising to read that, "according to the forty-fifth annual report of the registrar-general, the mortality of miners is less than that of the general aggregate male population." The statement, however, appears to be clear and definite, and is evidently official. It is repeated in an extract from a letter from Dr. Ogle, embodied in the same report, to the effect that "the death-rates of miners are surprisingly low. In spite of their liability to accident, the comparative mortality of these laborers is considerably below that of all males."

When the *Colliery Guardian* goes into an analysis of the figures, however, it plunges into a labyrinth of perplexity to which the clue seems to be lost. Here are the statements *verbatim*; let the reader work out his own solution who can. "The registrar-general states that the mortality of miners (including accidents), is 883 per 1,000, as compared with 1,000 of all males of the population (including accidents). The full figures are the following: the deaths per 1,000 of all males are 933, and the accidents 67, together 1,000. For the miners the deaths from ordinary causes number 697, and from accidents 186, together 883; so that there are less deaths per thousand amongst the miners than amongst the general male population."

That the deaths and accidents among "1,000 of all males of the population" will eventually be "together, 1,000" is beyond peradventure; but, if the statement be taken in this sense, we should have to infer that among the miners only 883 of every 1,000 died at all, and the rest emulated the patriarch Enoch or realized the adjuration of the Persian courtiers to their king and "lived forever." To construe the figures as annual returns would involve the peculiar conclusion that all the males in the kingdom died off each year, except among miners, where about 117 per 1,000 survived into the next season. The *Guardian* will have to supply the proverbial "diagram." To return to more comprehensible propositions, Dr. Ogle considers that, if we "exclude the accidents, the mortality of the coal miners only slightly exceeds that of the most healthy class of men in our land,—namely, the agriculturists; that is to say, the agricultural laborers, the farmers, and the gardeners." And the accidents do not seem to be so numerous or so fatal as the public supposes.

"On August 15, 1890, a return was made to an order of the house of commons which showed that, out of a total number of 581,809 persons employed in coal mines, the proportion of persons injured was 7.36 per 1,000. It is true, Dr. Le Neve Foster makes the number higher, but he relies on an hypothesis, and he takes in slight accidents. Of the number of men killed, the proportion per 1,000 in 1893 and 1894 was 0.9."

These general figures are nearly borne out by the report of her majesty's inspector of coal-mines for Yorkshire and Lincolnshire, where about 90,000 persons are employed. From this it appears that the accidental deaths in 1895 were only one to every 977 miners, or to every 256,258 tons of mineral produced.

In support of the healthfulness of the occupation, a "medical man" is quoted to the effect "that in certain districts the mining population was entirely exempt from the terrible disease of cancer, to which the rest of the population round about them and in the midst of which they lived were liable; and that this was attributable to the habits of cleanliness necessarily engendered by their occupation." In other words, it must be healthier to get very dirty indeed and then wash than to keep moderately clean all the time.

The Peruvian Oil-Fields.

THE AMERICAN MANUFACTURER publishes some information concerning the petroleum output of Peru, derived from a paper originally prepared by Dr. H. Polakowshy of Berlin, translated into Spanish for *La voz del Sur* (Lima) and retranslated thence for the *Manufacturer*.

The data appear to have suffered a little here and there, possibly in their linguistic double somersault; for their insufficiency, however, the responsibility attaches solely to the revolutionary disturbances of the country and the temperamental lack of energy among its officials. Some figures, Dr. Polakowshy states, were published by the government engineer, Federico Moreno, in the *Bulletin of the Lima Geographical Society* in 1893; but the political unsettlements following seem to have stopped the work. The figures given by Dr. Middendorf, Moreno's coadjutor in the collection of the latest statistics, are as follows:

"In 1885, 650,000 liters were produced; in 1888, 1,001,000; and in 1891, 2,802 000. In 1892, 49 wells produced 500,000 barrels of 160 liters each (3¾ liters=1 gallon); the United States produced in the same year 15,000,000 barrels. The Peruvian oil field is located in the department of Piura near the coast, extending from Punta de Aguje to Tumbes,—a distance of more than 400 miles. The country is very sparsely settled, practically an arid waste."

"The region has not been thoroughly explored yet. According to an estimate made by E. P. Larkin, New York, 1866, an American engineer, who lived three years in the province of Tumbes, the oil district comprises an area of 7,200 square miles. Mr. Faiville (Petroleum, Paris, 1818) estimated the area of Tumbes at 16,000 square kilometers, while the estimates of F. Hue and B. Creso agree with that of Larkin. All these explorers locate the oil district between Cabo Blanco, 50 miles north of Paita, and the Charan range, about 10 miles south of the Tumbes river. This district may be considered the greater part of the northern oil region. Besides, petroleum deposits have been found at other points along the coast. The only thing lacking in the development of these natural resources is energy."

Mr. Moreno estimates the area of the entire Peruvian oil field at 32,000 square kilometers, which he divides into three zones:

"1. The northern field from the province of Tumbes to the Mancora range and 100 miles from the Tumbes river.

"2. The central field from Punta Soco, in the Mancora range, to Punta de Lobos.

"3. The southern field, extending from 400 to 16,000 meters from the coast, between 80.58° and 81.11° longitude and 5.41° and 6.10° southern latitude. This field is traversed by several mountain ranges of 1,200 feet height, which end at the Punta Pisura on the Sechura bay. In wet years these hills furnish good pasture; there are also several good harbors in this district."

"The oil wells in all these fields are less than 800 feet deep. Oil has been found at some places even at a depth of but 30 feet. The wells are located on the side of a hill or in a ravine, so that the oil can easily be collected at some lower place.

"According to Moreno, it is necessary, in reaching the real geological oil strata, to drill to a depth of 1,200 feet, and only then can a definite success be expected when gas commences to escape. The pumps are required when the wells are drilled deep. In the Tumbes district the wells are all located in the plain, and, when one is exhausted, another one is drilled. These wells were not very productive, but the producers were forced to adopt this method of working, because until 1888 proper machinery was lacking completely. It is more convenient to drill the wells at the foot of a hill or in the mountains."

"The Tumbes as well as the Negritos field, which is now being explored, is level. The surface strata consist of conglomerate."

This level country must interfere with the convenience of the energetic prospectors who prefer a situation where even the crude oil can be spared any labor, except that of sliding down hill.

The development, however, seems to be progressing, largely under the stimulus of English capital and engineering skill, although Mr. Moreno recommends that the petroleum industry be made a government monopoly.

"Crude oil is being used, instead of coal, as fuel for the locomotives on all Peruvian railroads, as well as in many manufacturing establishments and gas works. The price is 20 soles (about ten dollars) per ton. It is a cheap fuel, and has scored a great success. Large quantities are exported to Chili for the same purpose. All the companies now engaged in developing the oil fields are strongly organized in financial respect. The most prominent are: Zorritos, capital £100,000; Talara, £250,000; and Heath, £25,000. There are a number of others of less importance: the Peruvian Petroleum Company, capital, £20,000; the Mancora Peru Petroleum, £12,000; the Union Petroleum Syndicate, £10,000. The works nearest to the Tumbe river belong to F. G. Piaggio, to whom a gold medal was awarded at the South American Exposition of 1884."

One of the most curious points noted is "the discovery by the English engineer Chenhall that, by adding to boiled petroleum Quillaya root (38 grams of the root to 1,000 grams oil) the oil can be changed into a solid substance, the transport being greatly facilitated." The oil itself, as shown by the subjoined analyses, is very similar to the Russian, and quite different from the American petroleum.

	United States per cent.	Russia. p. c.	Peru. p. c.
Carbon	49.1	87.4	84.9
Hydrogen	6.3	12.5	13.7
Oxygen	44.6	0.1	1.4

It certainly seems to offer an excellent opportunity to the "men and energy" whose absence Mr. Moreno deplores.

Two Investigators of Irrespirable Air.

A CURIOUS study of highly contrasting investigations of similar phenomena is afforded by a comparison of two papers recently noticed in mining exchanges.

The first, abstracted in brief in the *Engineering and Mining Journal*, was presented by Frank Clowes, D. Sc., at a recent meeting of the British Association, and embodies the results of Dr. Clowes's experiments on the "Respirability of Air in which a Candle-flame is Extinguished." Mixtures of air, nitrogen, and carbon dioxid were prepared, tested, and varied, until it was found that a mixture of about 16.5 per cent. of oxygen and 83.5 per cent. of the extinctive gases would just extinguish a candle. Conversely, the residual gases, after allowing a candle to burn to extinction in pure air confined over mercury, were found to present almost this same composition. "Now, an atmosphere of this composition," says Dr. Clowes, "is undoubtedly respirable. Physiologists state that air may be breathed until oxygen is reduced to 10 per cent. The maximum amount of carbon dioxid which may be present is open to question, but it is undoubtedly considerably higher than 3 per cent; the conclusion to be drawn from these facts is that an atmosphere must not be considered to be dangerous and irrespirable because the flame of an ordinary candle or oil lamp is extinguished by it. The view is very generally advanced that a man must on no account venture into air which extinguishes the flame of a candle or of a bundle of shavings. It will be seen that this precaution may deter one from entering an atmosphere which is perfectly safe and respirable, and from doing duty of a humane or necessary character."

Unfortunately, it will immediately occur to most readers that the "air which extinguishes the flame of a candle or a bunch of shavings" may obstinately be much more than "just able to extinguish" this flame. Not only Dr. Clowes's experimental mixture of "16.5 per cent. of oxygen and 83.5 per cent. of the extinctive gases," but every mixture worse than this, will be equally efficacious, and all that the experimenter can learn from the test is that the atmosphere in question contains certainly as little as 16 per cent. of oxygen, and maybe none at all; nor will he gain any information as to the other poisonous gases so often present in the doubtful cases which Dr. Clowes professes to aid.

Any effort in furtherance of "humane or necessary" work is commendable, but it is hardly likely that the would-be rescuer who sees his test flame extinguished will gain much encouragement from these laboratory results. Further, the sad history of accident and rescue suggests rather the need of restraining reckless bravery than of encouraging additional risk.

Very different is the tone of the second paper, prepared under parliamentary auspices by Dr. Haldane, whom Dr. Clowes quotes, and published in *The Colliery Guardian*. It is based upon stern and grewsome data—"the bodies of the men and horses killed at Tylorstown"—"from the examinations of the bodies found in all parts of the pit, and from the symptoms of the rescuers." The most significant feature of the difference is that, far from searching for conditions under which the ordinarily-accepted danger-signs may be disregarded, Dr. Haldane is continually alert to devise means of detecting the danger which may lurk behind apparent indications of safety; to find the minimum of injurious gases which can be detected, not the maximum which can be endured.

He dwells especially upon the poisonous effects of carbon monoxid, to which he attributes the larger share of the terrible death-roll from colliery accidents, and emphasizes the fact that its recognition "is a matter of much practical importance, and many lives have been lost through ignorance of the fact that the lamps—to which miners trust for the recognition of other gases—give no direct indication of carbon monoxid." He calls attention to the particular dangers arising from the fact that it is insidious in its action, and may suddenly overcome a man when he has progressed so far into the vitiated atmosphere that he can not make his way back; advises such disposition of relief parties that a reserve may always be at hand; and suggests the keeping and carrying of mice in suspected places, as they show the symptoms of carbon monoxid poisoning very much sooner than men.

He gives some space also to sulphurous acid,—another poisonous gas which has no effect on the flame; carbonic acid he exhibits as an active anesthetic poison, not merely (as generally supposed) a mere diluent of the air.

Instead of seeking reassurance from the fact that a certain mixture may extinguish a flame and yet support respiration, he publishes investigations showing the possibility to have a combination of oxygen and carbon dioxid in which a flame will burn while a man would be rapidly overcome.

Probably he would unhesitatingly endorse Dr. Clowes's closing deduction that "undoubtedly the candle and lamp flames should be discarded as absolute tests of the respirability of air," but there would be a world of difference in his meaning.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Mining and Engineering Journals—See Introductory.

Metallurgy.

*6705. The Bessemer Steel Industry of the United Kingdom in 1895 (Statistics collected from the manufacturers by the British Iron Trade Assn. in regard to the production of ingots, of Bessemer steel rails, of finished steel, and extent of employment of plant). Ir & Coal Trds Rev-June 12. 1000 w.

*6706. The Open-Hearth Steel Industry of the United Kingdom in 1895 (Statistics dealing with the production of ingots, of finished open-hearth steel, and of open-hearth furnaces, with a comparison of British and American output). Ir & Coal Trds Rev-June 12. 900 w.

6715 Manganese and Manganiferous Ore in Spain. Reginald W. Barrington (Brief accounts of the districts producing the largest quantities during 1895, with analysis of the ore). Am Mfr & Ir Wld-June 19. 400 w.

†6796. Improvements in Gold Extraction H. Livingstone Sulman, with Discussion (Detailed description of results of experimental work relating to some of the problems which have recently become prominent in the modern processes of gold extraction—viz., the application of an improved cyanide solvent to refractory ores; a new method of precipitating gold from solutions of potassic cyanide, and the leaching of slimes) Inst of Min & Met. Lond-Vol III Pt II. 22500 w.

†6856. The Sulphuric Acid Process of Refining Lixiviation Sulphides. Frederic P. Dewey (Read before the Washington Section of the Am Chem. Soc. A description of the Dewey-Walter process with summary of statistics). Jour Am Chem Soc-July. 3400 w.

†6857. Notes on the Electrolytic Determination of Iron, Nickel and Zinc H. H. Nicholson and S. Avery (Results of investigations). Jour Am Chem Soc-July. 1700 w.

*6952. The Accumulation of Amalgam on Copper Plates (Facts observed in the 50-stamp "combination" mill operating the Drum Lummon mine, situated at Marysville, Montana). Aust Min Stand-May 21. 1800 w.

6976. Methods in Use for the Analysis of Ores, Pig Iron and Steel by the Carnegie Steel Co. John S. Unger (Report in response to a request from the Chemical Section of the Engineers' Society of Western Pennsylvania asking for the co-operation of chemists in an effort to collect for publication the methods in general use for the analysis of ores, pig iron and steel). Eng News-July 9 4000 w.

Mining.

6562. The Effect of Trap-Doors in Mines; their Use, Abuse, and the Extent to Which They May be Avoided. James Blick (Read before the joint meeting of the W. Penna. Central Mining Inst. and the Ohio Inst. of Mining Engs. Favoring the treble entry system, and setting forth its advantages). Am Mfr & Ir Wld-June 12. 1900 w.

*6577. The Position of the Coal Dust Question (Review of the question, experiments and investigations, especially the investigations of Mr. Donald Stuart of the explosion in Camerton Colliery). Col Guard-June 5 3500 w.

*6589. Methods of Opening and Working Coal Mines (Deals with boring and sinking, with illustrations showing the plan of surface arrangements of the South Wilkesbarre Colliery). Ir & Coal Trds Rev-June 5. 2000 w.

*6590. Haulage in Coal Mines (Description of the systems in operation, with reference to the account of M. A. Pernolet, of the mechanical appliances used in England and Germany). Ir & Coal Trds Rev-June 5 Serial. 1st part. 2800 w.

*6591. Coal-cutting by Machinery—Its Present and Its Future (Review of the history of the use of machinery in lieu of hand labor in mines). Ir & Coal Trds Rev-June 5. 3500 w.

*6592. The Lighting of Collieries by Electricity (The rapidity with which the electric light is being adopted for this purpose with account of installation and some difficulties, and examples where this mode of lighting is used). Ir & Coal Trds Rev-June 5. 2800 w.

*6594. Colliery Pumps and Pumping Operations (The rapid progress made in late years in this branch of colliery engineering, with examples especially of the application of electricity). Ir & Coal Trds Rev-June 5. 2500 w.

*6595 Electric and Other Safety Lamps (Brief illustrated description of various types). Ir & Coal Trds Rev-June 5. 1200 w.

*6596. The Screening and Washing of Coal (The importance of the mechanical preparation of coal, with description of screens in use). Ir & Coal Trds Rev-June 5 Serial. 1st part. 1700 w.

†6646. The Design of Top Work for Coal Mines. F. W. Rickart (The paper discusses top work only. Location, output, methods of grading, hoisting outfit and dumping are considered). Tech-May, '96. 4400 w.

*6721. Precautions Necessary in the Use of Electricity in Coal Mines. H. W. Ravenshaw (Abstract of a paper read before the Federated Institution of Mining Engineers. A few suggestions the carrying out of which may serve to minimize the risk both from shock and fire). Elect'n-June 12. 2900 w.

*6725. Dangers from the Use of "Safety" Fuse in Fiery Mines (From a communication to *Gluckauf* by Bergassessor Winckhaus, with reference to some observations by Bergrath Kaltheuner, of Gelsen Kirchen). Col Guard-June 12. 2600 w.

*6726. The Gobert Freezing Process of Shaft Sinking. A. Gobert (Read at meeting of the Federated Inst. of Mining Engs., London. Description of the direct freezing process). Col Guard-June 12. 2500 w.

*6754. The Coal-Fields of Kent (Illustrated description of the coal bed now being opened, which has, at least estimate, an area 150 miles in length and 6 miles in breadth, and it is calculated that they will be capable of supplying 3000 tons a day for seventy years). Mach, Lond-June 15. 3500 w.

6767. Early Iron Mining in Michigan. William P. Kibbee (Historical account of discovery and early development). Ir Age-June 25. 2900 w.

6768. History of Cripple Creek (Briefly told from the day the first stake was put in the ground. Its early struggles and final success as a great gold camp. Ill) Min Invest-June 20. 4200 w.

6792. Improvements in Blasting Operations in Collieries. M. C. Ihlseng (Read before the joint meeting of W. P. C. M. I. and the O. I. M. E. A review of the different explosives in use, showing why some are unfit for use in certain mines, and urging improvement in the grade and greater care in the use of these materials). Am Mfr & Ir Wld-June 26. 2800 w.

6793. Petroleum in Peru. Dr. H. Polakowsky (A detailed description of the rich oil deposits which exist in certain parts of Peru). Am Mfr & Ir Wld-June 26. 1800 w.

†6794. Mining Reports and Mine Salting. Walter McDermott, with Discussion (Remarks against the indiscriminate use of terms familiar in mining reports, used as catch-penny phrases in a way to imply more than they really mean. The fixing of mines for selling and the danger from these sources). Inst of Min & Met, Lond-Vol. III, Pt. II. 15800 w.

†6795. Gold Mining and Milling in the Black Hills (S. Dakota). C. G Warnford Lock, with Discussion (General description, treating of the geological formation, auriferous veins and other deposits, the methods of mining and milling). Inst of Min & Met, Lond-Vol. III, Pt. II. 17000 w.

†6797. The Covadonga Manganese District and Its Mines. J A. Jones (Brief account of the discovery, situation, mode of occurrence, workings, cost of extraction, quantity, etc). Inst of Min & Met, Lond-Vol. III, Pt. II. 2800 w.

†6798. The Manganese Deposits of Huelva. Frank Johnson (Description of deposits). Inst of Min & Met, Lond-Vol. III, Pt. II. 3200 w.

†6799 Notes on the Espiritu Santo Mine at Cana ; Its Drainage and Recovery. Ernest R. Woakes (Past history of the mine, account of exploration of the mine in 1892, and the more recent work It is a most interesting mine with an interesting history). Inst of Min & Met, Lond-Vol. III, Pt. II. 4500 w.

*6806. Mining Tenure in Western Australia. Raymond Radclyffe (Showing how the interests of investors are jeopardized by the anomalous state of the law, and emphasizing the necessity of reform). Min Jour-June 20. 1200 w.

*6807. The Present Position of Gold Mining in West Australia. Carl Schmeisser (A description of the studies of the writer on these gold fields. The first part deals with their geographical and geological relations and the auriferous deposits). Min Jour-June 20. Serial. 1st part. 4500 w.

*6810. Wilmotte Stops for Mine Cages (From a communication to the Liège Engineers' Association by M. Louis Eloy, engineer at the Kessales Colliery, Jemeppe, Belgium. Illustrated description, with a consideration of the conditions to be fulfilled by a good set of stops). Col Guard-June 19. 3000 w.

6823. Lead and Zinc Deposits in Iowa. A. G. Leonard (Brief account of the deposits, working of mines and output). Eng & Min Jour-June 27. 1900 w.

6825. The Gold Mining Industry in Georgia and Alabama. William M. Brewer (A review of the outlook in these fields, and the conditions affecting the industry). Eng & Min Jour-June 27. 1600 w.

*6879. Some Notes on the Mount Lyell Mine, Tasmania. Sydney Fawns (A paper read before the Inst. of Min. & Met. Treats of the history, natural features, ore deposit, mine workings, treatment of the ore, and costs). Min Jour -June 27. 2200 w.

*6880. The Copper Mines of Lake Superior. W. P. Kibbee (A statement of the prevailing conditions and some account of the surface workings of the Calumet and Hecla mine are given in part first). Min Jour-July 27. Serial. 1st part. 1600 w.

6903. Useful Effects of Air Splits and the Limits to Which They May Be Usefully Applied. Charles Connor (Condensed from a paper read before the joint meeting of the Western Penn. Central Mine Inst. and the Ohio Inst. of Min. Engs. The subject is discussed theoretically and practically ; the advantages of air splits are stated and their limit in practice). Am Mfr & Ir Wld-July 3 1600 w.

6907. Cripple Creek Gold Production. Edward Skewes (A denial of some published statements, with corrections). Eng & Min Jour-July 4. 1500 w.

6908. A New Type of Mining Locomotive. Timothy W. Sprague (Illustrated description of a new type of mining locomotive built by the combined Baldwin and Westinghouse Companies). Eng & Min Jour-July 4. 800 w.

6909. The Electric Light in Mining Operations. William Baxter, Jr. (The advantages and disadvantages, cost, etc., efficiency and practicability). Eng & Min Jour-July 4. 1100 w.

6910. Gold Mining in the Appalachian Belt. W. H. Adams (Reviews the prospects, suggests the dividing of the territory into districts, commends paper on the subject by Messrs. Wilkins and Nitze, and states that the mine future of this belt must rest on ability to work low-grade ores). Eng & Min Jour-July 4. 2000 w.

6911. The Coal Beds of California. Harold W. Fairbanks (Notes stating briefly the occurrence of coal in this state and what the prospects are for the development of the industry). Eng & Min Jour-July 4. 1100 w.

6913. Coal Briquettes. N. G. Neare (One of the many ways of utilizing waste product). Tradesman-July 1. 2000 w.

*6927. Working Thin Seams in the Franco-Belgian Coalfield. M. F. Cambessédès (From a communication to the Société de l'Industrie Minérale. Describes working by shoots, and the working of very thin seams near ordinary seams and by forward stalls). Col Guard-June 26. Serial. 1st part. 3500 w.

*6938. Possible Economies in Coal Working (Discussing how far it is possible to introduce further economies and thus enable profits and wages to be improved). Ir & Coal Tr Rev-June 26. 2400 w.

*6939. Coal Miners and Their Work (Treats of the difficulties arising from mining disputes, and the increased safety of working). Ir & Coal Tr Rev-June 26. 1800 w.

*6941. Iron and Manganese. Arthur Lakes (Illustrated description of the great Cebolla River deposits. The location,g eology, topography and development of the greatest beds of iron and manganese known in the world). Col Eng-July. 2400 w.

*6953. The Tate Tin Mines (Q.) W. H. Bain, in the *Wild River Times* (Description of the largest and most important of the stream tin-mining properties now being worked in North Queensland). Aust Min Stand-May 28. 900 w.

*6954. Rokeby Gold Mining Company, Gippsland (A brief account of a promising property). Aust Min Stand-June 4. 1200 w.

Miscellany.

*6506. The Utilization of Anthracite Culm. Ill. Edward H. Williams, Jr. (Showing the amount of culm sent to the dump, the ways in which it has been wasted, and the methods by which it may be made available for fuel purposes). Eng Mag-July. 3700 w.

6520. Asbestos. George Heli Guy (The importance of asbestos to the human race, its characteristics, where found, process of manufacture, uses, and newest departures). Elec Eng-June 10. 3400 w.

6526. Manufacture, Use and Abuse of Dynamite. H. A. Lee (The dangers of dynamite manufacture, the storage and age of powder, freezing temperatures, with a caution not to hurry back to a shot). Min & Sci Pr-June 6. 1800 w.

6535. Statistics of the Iron and Steel Industries (Review of the domestic iron trade as presented in the annual report of the American Iron and Steel Assn. A table compiled from figures given in the report shows in convenient form the condition of these and allied industries). Eng News-June 11. 1600 w.

*6579. Wire Mining Ropes. J. Bucknall-Smith. Their technology, manufacture and uses). Min Jour-June 6. Serial. 1st part. 1500 w.

*6597. The Cost of Producing Coal in Different Countries (The countries discussed are the United States, England, or Great Britain, Germany and Belgium). Ir & Coal Trds Rev-June 5. 1400 w.

*6685. The Land of Gold (Review of book by Julius M. Price on the West Australian gold field). Trans-June 12. 2500 w.

6716. Refractory Material. Walter Hempel and Waclaw Jezierski, in *Chemische Industrie* (Describes the results of an investigation of a peculiar mineral found in Norway, Southern Tyrol and the United States). Am Mfr & Ir Wld-June 19. 800 w.

*6728. On the Industrial Products of the Geological Formations of the United Kingdom (The first of a series of articles aiming to note and consider every strata which in any way affords employment for labor. This part deals with the products of the Pre-Cambrian and Archæan rocks, the Silurian and the Devonian). Col Guard-June 12. Serial. 1st part. 3800 w.

*6809. The Causes of Death in Colliery Explosions (Extract from a parliamentary paper, with special reference to Tylorstown, Brancepeth and Micklefield explosions. The report was prepared by Dr. John Haldane). Col Guard-June 19. Serial. 1st part. 8000 w.

6839. Regenerator Effects on Producer Gas. Jno E. Fry (Letter to the editor, containing discussion of paper by John H. Darby, and examining his views). Ir Age-July 2. 1000 w.

*6878. The Water Difficulty in Western Australia. Raymond Radclyffe (Its importance to the industry of mining and to investors. A statement of the condition of affairs with suggestions for conquering the difficulties). Min Jour-June 27. 1800 w.

6912 The Iron Products of Texas. James F. Fuller (An interesting paper on the iron interests of this great state read before a recent meeting of Texas Foundrymen). Tradesman-July 1. 1800 w.

*6942. Hoisting Machinery. William M. Morris (Illustrated description of a proposed modification of the Koepe system). Col Eng-July. 1700 w.

*6943. Mining Safeguards to Increase the Security of Miners (Valuable instructions from Bulletin No. 1, Colorado State Mining Bureau, by Harry A. Lee, Commissioner of Mines). Col Eng-July. 3500 w.

*6944. Economies in Mining by the Use of Mechanical Appliances. Cyrus Robinson (The advantages gained by their adoption, with statements of their economy and the conditions suited to the different kinds). Col Eng-July. 2900 w.

*6945. Doors in Mines. James Blick (Their effect on the air currents; their use, abuse, and the extent to which they may be avoided. Read before the joint meeting of the West. Penna. Cent. Min. Inst. and the Ohio Inst. of Min. Engs.) Col Eng-July. 2000 w.

*6946. Coal Handling. J. J. Ormsbee (Read at the meeting of the Eng's Assn. of the South. A description of the hauling and dumping plant at Pikeville, Tenn). Col Eng-July. 1500 w.

*6947. Fire Damp. F. C. Keighley (Read before the Ohio Inst. of Min. Engs. Experiences of a mine manager in some of the gaseous mines in the Connellsville, Penna., region, with deductions drawn from the same). Col Eng-July. 4200 w.

MUNICIPAL ENGINEERING

Ashes as a Source of Municipal Revenue.

It has not been generally recognized that clean coal ashes might not be wholly a charge upon cities for their removal, and that, on the contrary, they might be made a source of municipal revenue. It has remained for one of the most intelligent and progressive street commissioners New York city has ever had, Col. George E. Waring, Jr., to bring this fact prominently before the public. This he has done in the last edition of his "Report on the Final Disposition of the Wastes of New York," just issued.

We have before had occasion to speak in praise of this model document, but will here take occasion to say that the present edition has been revised and enlarged, by additional discussions of practical topics, by the presentation of more complete information and data, and by a number of illustrations which the first edition did not contain.

Returning to the subject of ashes,—the amount collected in New York city is estimated at 1,500,000 cubic yards. Col. Waring says that, on account of the mixing of garbage with ashes, these ashes were made unfit for useful purposes. Hence their removal has been an unmitigated charge upon the city. Knowing that there was some demand for clean ashes, for filling, he studied the extent of the demand, and now clearly demonstrates that, if kept free from garbage, a considerable portion of the cost of their removal may be reimbursed to the city by their sale. The demand has been found to extend much further than for filling purposes. He says this study has convinced him "that clean ashes have become so valuable for building operations that contractors will gladly pay the small amount per cubic yard which will requite the city for storing the ashes at the dumping-stations for the few hours or few days that may be necessary at different times of the year, and which will, to the extent of the ashes thus used, leave the expense to the city only that of collection.

"The present cost of ashes delivered at new buildings is supposed to be merely the cost of hauling; but, while in cold weather the price is 25 cents per load of one cubic yard, it frequently rises during the summer to 60 cents per load, and is seldom less than 50 cents between March and November. This is due, of course, to the scarcity of ashes during nine months of the year; and I am assured by various builders that it would be a boon to them if clean ashes could be regularly procured at a small cost for storage, at the various department dumping-stations which, happily for builders' convenience, are well distributed along the river fronts. They say that under such circumstances the city's household ashes would be used as rapidly as made, certainly for six months of each year, probably for nine months. Those best fitted to judge are of opinion that the household ashes will be entirely suitable for builders' needs, though they differ materially in character and appearance from steam ashes."

One of the uses for clean ashes is in the laying of side-walks, flagging, etc. Col. Waring finds that about 1,200,000 square feet of side-walk were laid in the city of New York in 1895, which, with an average underlaying of ashes (four inches), would require about 15,000 cubic yards. Ashes are also used as a substratum for cellar floors; and, if the year 1895 be taken as a standard year in building, it is estimated that about 200,000 cubic yards are needed for this purpose. Similarly, it is computed that 600,000 cubic yards would be needed in the construction of fire-proof floors.

It is thus seen that the present demand for clean ashes would absorb a notable part of the actual product. These ashes have hitherto been chiefly obtained from manufacturing establishments using steam power, the demand having been greater than the supply, so that substitutes, such as gravel, etc., have been used. Ashes appear to fill in a high degree the requirements for a loose, dry substratum on which stone or cement for walks, etc., ought to be laid, and contain enough interstitial space for the expansion of moisture in freezing, without upheaval. A further use in the manufacture of brick and concrete appears possible. On this point Col. Waring says:

"Quite lately, and during the collection of data for this paper, I have found in experimental operation, by the use of a cement whose constitution was kept a business secret, a process for making from ordinary house ashes either concrete, or stone in mass, or brick, in appearance at once pleasing to the eye and suggestive of considerable strength and toughness.

"For the purpose of determining the suitability of this material for building purposes, I had tests of its strength under compression made on the Emery Testing Machine, under direction of Prof. Ira H. Woolson, of the School of Mines, Columbia College. All pieces tested were approximately two-inch cubes; some moulded to that size, some cut from the interior of large bricks; all said to be less than thirty days old, and made without pressure; all having specific gravity about 1.78, that of ordinary brick being 1.8 to 2.0."

Specimens of these mixtures in various proportions, none of them more than thirty days old, have shown, under test, a resistance to crushing of from 5,000 to 10,000 pounds per square inch. But under the weather test these bricks utterly failed. The material appeared to do well under fire test, but this test was not carried out to definite conclusions.

The possible use of ashes for bricks, etc., therefore remains problematical. To give these bricks the proper weathering quality appears to be the principal desideratum yet to be attained in their manufacture.

Danger to Health from Unclean Streets.

In line with what was said by Mr. Post, the eminent architect, at a recent meeting of the American Institute of Architects (see review in our architectural department, July number), is an article in the *New York Medical Journal*, which gives a plain statement of the danger that may lurk in dark and uncleaned streets and alleys.

This article, of which a brief abstract follows, asserts that we know, beyond all question, that certain disease-producing bacteria live and flourish in filth. Of these, one of the most fatal, which for obvious reasons is almost universally present in street dirt, is the germ of tuberculosis,—the cause of pulmonary consumption.

The researches of Dr. Prudden have shown that the dirt of streets, even when, as dust, it is blown high into the air, is full of bacteria. In cities we breathe air more or less charged with pulverized horse-droppings and other filth, intermingled with the bacteria named and those of other kinds; and our clothing becomes more or less saturated with this unwholesome mixture. The "*more*" or "*less*" depends upon the thoroughness—or want of it—in cleaning the streets and exposing them to solar light. "The fact that in hot weather, when the windows are open, the filth makes itself a portion of our meals, which, though not mentioned in the bill of fare, is served with more or less profusion *gratis* with every portion of food, is an additional reason for objecting to dirty streets; and our objections become stronger when we think how often, at all seasons of the year, it must contaminate the milk supplied to little children and invalids.

"It is not infrequently asserted that we have no absolute proof that, as a matter of fact, disease is caused by city dirt. This is quite true, but can any sane man deny that there are strong reasons for believing that disease is produced by pathogenic bacteria contained in this dirt? We know that the bacillus tuberculosis is capable of distribution with dust, and it is quite possible that the same is true of a number of other disease germs. Whether or not pathogenic bacteria are thus distributed, no one can deny that such dust is injurious to the respiratory organs, and it must be remembered that upon any one who asserts that the introduction of filth such as this into the body is harmless rests the burden of proof of his assertion quite as much as it would had he stated that it was harmful."

The article closes with the expression of a belief that the death-rate of New York city, which is higher than it ought to be—has been increased by the imperfect cleaning of streets prior to the present administration of the street-cleaning department,

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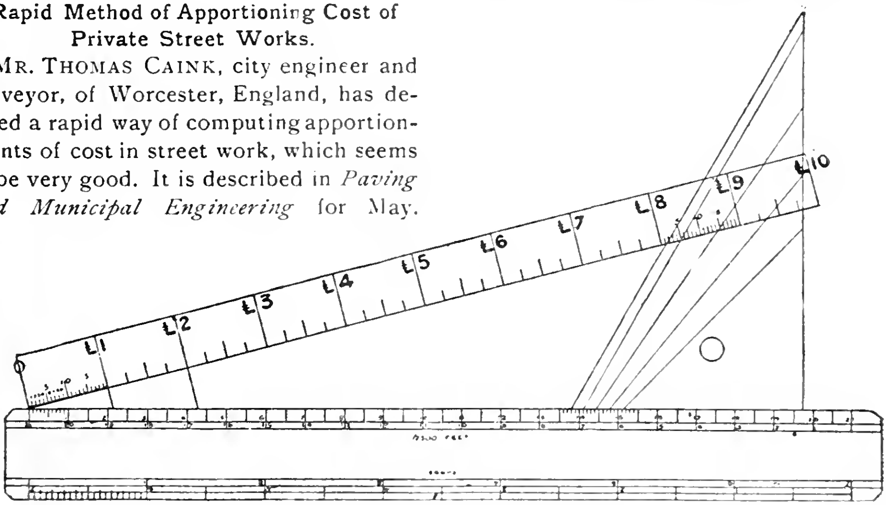
Rapid Method of Apportioning Cost of Private Street Works.

MR. THOMAS CAINK, city engineer and surveyor, of Worcester, England, has devised a rapid way of computing apportionments of cost in street work, which seems to be very good. It is described in *Paving and Municipal Engineering* for May. They are as follows: 1-500th yards, 1-500th feet, 1-2,500th yards, 1-2,500th feet, two chains to an inch, with corresponding feet on opposite edge, and one chain to an inch, with corresponding feet.

"There is no need for so many scales, but these were selected as being of general usefulness, and at the same time as giving ample range to meet every case.

"The manner of using the scales is as follows: having ascertained the total cost of the work and the total length of the numerous frontages (which is most con-



RAPID METHOD OF APPORTIONING COST.

Leaving out much that is said of the origin of the device and its economies, we reproduce the engraving illustrating it, and the description of its use.

"As the instrument can be made by any draughtsman, the author thinks there may be town surveyors who, desirous of reducing the time of the office expended in this work, may welcome such a device. It consists of a sheet of good card-board about thirty inches long by fifteen inches wide, on which is drawn a scale of £. s. d. (which can be changed to dollars and cents), several ordinary scales of different degrees of openness, and a rather large set square, the transparent kind being preferable.

"The other scales (which are of boxwood) are four in number, thirty inches in length, divided with a different scale on each edge, making eight scales in all.

veniently measured in yards and decimals), it is manifest that, if a scale of length can be found on which, when laid along the money scale, the total length of frontage coincides with the total cost of the work of the scale of £. s. d., then every other length will coincide with the cost of that length, and the sum due in respect of each of the various frontages can be read off directly from the scales. This is the simplest case that can happen, but one which hardly ever occurs.

"A scale, however, can be selected out of those mentioned on which the total frontage will *approximate* to the total cost. Having found such a scale, place its zero point upon that of the money scale, and lay a set square against the edge of the former (as shown in sketch) in such a position that one of its angles or corners touches the ascertained total length; then place the scales at such angle with the *£. s. d.* ($ c.) scale (by moving it to and fro upon the zero point at a pivot) that the edge of the set square just cuts the total cost upon the money scale. The two scales are then retained in position by two or three lead weights. The cost of the work in respect of the various frontages is then ascertained by sliding the set square along the edge of the boxwood scale and setting the angle at the points thereon corresponding to the lengths of the various frontages. It will be found that the edge of the set square cuts the money scale at sums proportional to the various lengths.

"In practice it will be found that the total cost and frontage usually exceed the length of the scales. In such cases it is only necessary to divide cost and length by such a common number as will bring the quotient within the range of the scales, and treat the quotients as though they were totals.

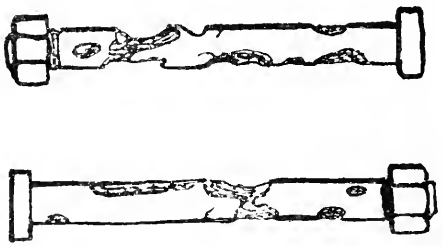
"It is important that the corners of the set square be set sharp, so as fairly to touch the wood scale. It is better, however, to use a transparent set square and scribe a line across it on the under side; a number of lines at various angles will be found convenient, being careful, however, to observe the same line throughout the same apportionment. The scribed line removes any difficulty in accurately placing the set square to the point on the scale of length which may arise in course of time from the rounding of the corners of the set square."

By using a magnifying-glass great accuracy can be obtained by the above method, while the time occupied in making an apportionment is only a small fraction of that necessitated by calculation. Mr. Caink says he has used this method for five or six years, and finds it very useful.

Corrosion of Iron by Raw Gas Tar.

THE employment of gas tar as a protection for iron surfaces is extensive; yet some facts recently brought to light show that, unless caution be exercised, tar so used may become a more active agent for destruction than the agents which it is intended to guard against.

Mr. F. J. R. Carula, at the April meeting of the Nottingham (England) section of the Society of Chemical Industry, presented an example of the action of gas tar upon iron, which is herewith reproduced from *The Gas World* (June 27), which obtained it from the journal of the society. The cut shows the appearance of two bolts, each twelve inches long and one and one-eighth inches thick. These bolts were used in a valve box as stops for the prevention of excessive rise of circular india rubber valves, and were, while in use, constantly immersed in water. The corrosion indicated in the cut is attributed to tar residues that percolated from the surface of the ground into the water wherein the bolts were immersed, and a chemical examination of the water showed that it contained free ammonia, albuminoid ammonia, chlorids, and carbonates, which could not otherwise be accounted for.



That this corrosive action is due to something communicated by the tar would also appear to be indicated by the fact that similar bolts in a pump at the same works used for raising tar, and that only, also show corrosion of a similar character, although not quite so pronounced. The bolts in another pump, lifting river-water in the same place, show no signs of corrosion, which goes some way to indicate the common origin of the damage in the two other cases.

From a consideration of the analysis of the water, given above, one may reasonably suspect that the presence of ammonium chlorid, a considerable constituent of some gas liquors, and which, therefore, must be frequently present in crude tar, may contribute to the corrosive properties of this water.

The remarkable character of the corrosion, localized, and leaving much of the surface almost untouched, suggests the formation of galvanic couples at a number of points, in the neighborhood of which the whole of the action has taken place. The oxid of iron that is sometimes present in wrought iron, in the form of slag left between the laminæ of which such iron is composed, may account for this peculiarity. Whatever the exact explanation may be, the examples certainly impress the necessity for neutralizing the cause of corrosion before using crude tar as a protection for iron surfaces.

The Journal of the Iron and Steel Institute, in 1892, stated, in a note derived from a German source, that raw tar ought to be heated with from two to three per cent. of lime to fit it for use as a protective coating for iron, thus neutralizing its free carbolic acid. While the action of this acid is destructive to iron, it is a preservative of wood. A structure composed partly of wood and partly of iron should have the wood parts painted with raw tar. But the analysis of the water from which the bolts shown in the cut were taken does not indicate the presence of carbolic acid. Instances are also mentioned of gasholders that have been damaged by the use of raw tar as a protective coating.

THE condition of the river at Cambridge, England, is to be improved. The town is being sewered on the separate system, and in the future rain water only will be carried to the river. The governing bodies of Trinity College and Trinity Hall have instructed Mr. Chas. E. Gritton, A.M.I.C.E., Westminster, to prepare plans.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Municipal Engineering in the American, English, and British Colonial Engineering and Municipal Journals—See Introductory.

Gas Supply.

*6523. A Suggested Remedy for a Source of Error in Official Photometry. Lewis T. Wright (The question of varying temperature as affecting not only the measurement of volume but also photometric tests, is discussed in this article which proposes a nominal standard of rate of consumption as a remedy for these inaccuracies). Jour Gas Lgt-June 2. 2000 w.

*6739. Inaugural Address of William Reginald Chester at the Meeting of the Incorporated Gas Institute (An extremely able survey of the past, present, and future of the gas industry, in which the cost of production is compared with that of electric lighting, both arts being considered in the light of the most recent advances in each). Gas Wld-June 13. 10700 w.

*6740. New Details in Gasholder Construction. E. Lloyd Pease (Short illustrated descriptions of details met with in the construction of modern gas-holders, in which some important matters are practically dealt with. Discussion). Gas Wld-June 13. 11000 w.

*6741. Gas Engines as Economical Motors. J. Holliday (Principally a comparison of different systems, with four tables of data, and discussion). Gas Wld-June 13. 6800 w.

*6742. Explosive Mixtures of Combustible Gases. Frank Clowes (Methods for detecting and measuring minute and dangerous proportions of such gases). Gas Wld-June 13. 4000 w.

*6743. Letting Gas Apparatus on Hire. Norton H. Humphrys (An exposition of a plan becoming more and more common in England. Faults pointed out and suggestions of remedies). Gas Wld-June 13. 3000 w.

*6744. The Popularization of Gas. A. Dougall (The coin-meter system is the principal topic, but the general supply of gas and hire of fittings are also treated, and a form of agreement for such service is presented). Gas Wld-June 13. 8400 w.

*6745. A Standard Photometer. W. J. Dibdin (A form of photometer suitable for adoption as a standard). Gas Wld-June 13. 2200 w.

*6746. Photometers and Standards of Light. W. Sugg (A broad treatment of the subject pointing out defects in instruments and methods, and a résumé of the history of photometry, with numerous illustrations. Discussion includes Mr. Dibdin's paper on the same subject). Gas Wld-June 13. 10000 w.

*6747. A Season's Experience with Incandescent Public Lighting. Frederick G. Dexter (Recent and extensive experience with the Welsbach light in street illumination in Winchester, Eng Results highly favorable. Discussion). Gas Wld-June 13. 6200 w.

6893. Welsbach Street Lighting. Frederick P. Morrill (The obstacles encountered and the extent to which they have been surmounted). Pro Age-July 1. 2700 w.

Sewerage.

6556. The Bristol, Conn., Sewage-Disposal Works (Brief description with plan. The system comprises both intermittent filtration and broad irrigation) Eng Rec-June 13. 400 w.

6557. The Sewerage of Victoria, B. C. (Abstract of a paper by Edward Mohun, read before the Canadian Soc. of Civ. Engs. Description of details). Eng Rec–June 13. 1500 w.

6789. The Vassar College Sewage-Disposal Plant (Illustrated, detailed description). Eng Rec–June 27. 2400 w.

Streets and Pavements.

†6655. Impact and Abrasion Tests of Paving Brick. H. J. Burt (Method of carrying out tests of this kind in the Laboratory of Applied Mechanics, University of Illinois). Tech–May, '96. 2300 w.

†6656. Street Improvements at the University of Illinois. John C. Quade (Illustrated description of work done in improving the grounds of the institution). Tech–May, '96. 1000 w.

6769. Hitch Your Wagon to a Star (Editorial remarks on the street cleaners' parade and the work of that department, with remarks on other subjects of municipal interest). Gar & For–June 24. 120c w.

6896. Work of the Street Department of Boston, Mass., in 1895 (Methods of the department; settling the lines dividing the districts; principal features of the work are summarized; copy of regulations and instructions issued; personnel of the officials of the force). Eng Rec–July 4. 2000 w.

Water Supply.

*6505. Filtration of Municipal Water-Supplies. Ill. Rudolph Hering (A comparison of rapid filtration with slow, and of continuous filtration with intermittent, accompanied by descriptions of the plants at Hamburg and Lawrence). Eng Mag–July. 4200 w.

6536. Asphalt Lining for Water-Works Reservoirs. L. J. Le Conte (Abstract of a paper read at the annual convention of the American Water Works Assn. Account of experiences with asphalt on the Pacific coast for the purpose named). Eng News–June 11. 2800 w.

6558. The Water Supply of Buenos Ayres (Translated and condensed from a memoir of D. E. R. Coni in the *Geni Sanitaire*. Illustrated description). Eng Rec–June 13. 1300 w.

†6648. Chemical Survey of the Water Supplies of Illinois. Arthur W. Palmer (Account of a series of recent examinations of the water supplies of the state of Illinois, carried out at the University of Illinois; and of an effort to arrive at a standard of purity for well waters). Tech–May, '96. 800 w.

†6649. Inspection of Water-Pipe Laying. Ralph P. Brower (Explanation of methods useful to inexperienced men). Tech–May, '96. 2000 w.

6710. The Nashua Aqueduct (Illustrated description). Eng Rec–June 20. 700 w.

6711. The Financial Management of Water-Works (Abstract of paper by Freeman C. Coffin, read before the New England Water-Works Assn. The purpose of the paper is to answer some important questions relating to receipts and expenditures, and the self-supporting or non-self-supporting character of municipal water-works systems). Eng Rec–June 20. 2500 w.

6788. The Construction of the Lower Otay Dam (Illustrated description of constructive work, interesting on account of its size and the unusual structural features). Eng Rec–June 27. 3500 w.

*6863. Why Water Meters Should Be Used (Abstract from report of engineer commission on water supply for Cincinnati. The same rules that apply to gas distribution should, the author believes, be applied to water distribution. Consumers should pay for the water they waste as well as for what they actually use). Pav & Mun Eng–July. 500 w.

6871. Sand Filter Beds for the Water-Works of Lambertville, N. J. Churchill Hungerford (Illustrated description). Eng News–July 2. 1400 w.

Miscellany.

6540. Raising Crops on Sewage Filter Beds (Experience at Pullman, Ill., at Berlin, Ont., and at South Framingham, Mass). Eng News–June 11. 1500 w.

6635. Testing of Brick and Cement (Description of the City Testing Works of St. Louis, Mo. They are said to be the most complete in the country, and test carefully all stone, brick and cement used in street paving). Clay Rec–June 15. 1700 w.

6709. Garbage Cremation Experiments in Germany (Condensed translations of three progress reports sent to Mr. Rudolph Hering from professional engineers in Germany. An exceedingly valuable and suggestive contribution to the literature of garbage cremation). Eng Rec–June 20. 4500 w.

†6756. The Introduction of Public Rain Baths in America. Harvey E. Fisk (Historical sketch. Difficulties met with and overcome by the promoter of this system. Illustrated description of these baths, and a statement of their sanitary advantages and the economy of the system). San–June. 7500 w.

*6862. Efficiency, Economy and Ethics in Municipal Engineering. Charles Carroll Brown (Faults in corporate action which result in disagreeable and expensive consequences, and their avoidance). Pav & Mun Eng–July. 1800 w.

6873. Garbage Disposal in England. James H. Fuertes (Abstract of a paper by Dr. J. Spottiswoode Cameron, published in *British Medical Journal*, with other information compiled and prepared by the writer). Eng News–July 2. 22co w.

6891. General Street Lighting. Walton Clark (The relation of street lighting to public health, safety, and morals is dwelt upon at some length and is followed by a general consideration of the problem of street lighting, with discussion). Pro Age–July 1. 3000 w.

6971. Garbage Disposal at Tacoma and Seattle. A. McL. Hawks (Illustrated description). Eng News–July 9. 1400 w.

6975. A Hydraulic Shield for Shallow Tunnels (An illustrated description of a shield designed especially for tunneling under city streets at small depths. It has been in successful operation for some months in constructing an outlet sewer in Paris, France. It is semi-circular in shape). Eng News-July 9. 1100 w.

RAILROADING

Articles of interest to railroad men will also be found in the departments of Civil Engineering, Electricity, and Mechanical Engineering

The Question of Track.

THE ENGINEER (London) of June 5 devotes considerable space to a discussion of permanent way, and, in the course of a two column editorial, develops a very comfortable satisfaction from the thoroughly expected conclusion that the English way is the best,—that the normal road (as it terms the bull-headed rail with chairs on widely-spaced sleepers) is "a survival of the fittest."

Not, it generously adds, "necessarily a survival of the best, but only of that best adapted to the conditions of British railway life."

The great differences in type and weight of rolling-stock might naturally involve corresponding differences in the permanent way, best adapted to each respectively; but it is hard to discover from *The Engineer* just where is this most admirable adaptation of English construction to local conditions.

The article apparently admits, as just criticisms, the statements that the maintenance of English track is costly, its surface rough, and the chairs bad for the rolling stock. Surely none of these things can be considered desirable, even in "British railway life." The treatment of derailments is neither satisfactory or reasonable, for the recent severe English accidents from this cause are attributed wholly to defective ballasting, while a general and unsupported assertion that in the United States such accidents are very common and very fatal is so made as to convey the impression that these accidents here are wholly due to the form of the flanged rail.

Even the bugbears of a dead past are unburied, and their specters paraded for fearful effect; we are assured that the flange rail has a constant overmastering desire to "turn over on its outer edge under the bursting stresses set up by the engines." Furthermore, "it eats its way into the sleepers, draws the inside spikes, becomes loose, and gives — especially on curves—an inordinate amount of trouble."

And yet the English rail, which, of course, does none of these desperate things, is admitted to be costly in maintenance: surely, here is a mystery.

Finally, it will quite surprise some of our railway men to learn that "in the United States sleepers are mostly of oak or hard wood," and that "the flange rail on a cross-sleeper road can only be a success when the sleeper is made of hard wood."

The statement that the bull-headed rail is far stiffer than the flange rail of the same weight will hardly pass unquestioned; and it is more than likely that the extra cost said to attach to the flange form of section is due to special conditions of supply and demand in the English mills.

The one argument of force is the cost of the larger amount of wood used in the American form of track. In England, where ties must be imported, this would be an important consideration; but the argument at its best could only excuse a bad practice on account of expediency; it could not establish it as a good one. It is strange, too, that this consideration of expense should seem to *The Engineer* so weighty when the purchase of ties is in question, and so unimportant when it lightly dismisses the heavy maintenance cost of English roads, or when it urges heavy stone-ballasting from end to end of every line.

As a matter of fact, it is highly probable that the "normal road" is so dear to the English heart, not because it is fittest, but because it was first; the English disposition abhors change. The original reason for its adoption was the supposition that the bull-headed rail could be turned over when one head was worn, and so present a new track surface without buying new steel. This has long been abandoned as impracticable, but the bull-headed rail obstinately survives.

The Engineer considers that "the arguments in favor of the American as compared with the English road are more matters of opinion than of fact, so far"; no doubt opinion does largely sway many debaters on both sides, but there are matters of well-established fact which have an important bearing on the question. One of these is that the perfect track must avoid extremes, either of rigidity or flexibility; the English form of construction, with heavy firmly-fixed chairs, at comparatively wide intervals, seems to err in both directions, being too rigid at the points of support, and too flexible between them. The rapid alternation of conditions as the wheel passes over spaces and chairs can not be good either for the track or the machinery supporting the moving load. The tendency is to "pump" the ties in the ballast, with probably more expensive wear and destruction and more dangerous loosening of the entire track than could result from the slight creeping of the flange-rail under the hook-headed spike.

The American practice certainly seems closer to the ideal blending of firmness and elasticity, and keeps the wear due to vertical undulation nearer to the surface. If more costly as to ties, it is cheaper as to ballast.

It is significant that the agitation for change is confined almost entirely to the other side. *The Engineer* finds among its many well-qualified correspondents "a drift of opinion in favor of a return to the old-fashioned flat footed rail spiked to cross-sleepers." We have no such important dissentient party in our country. As long as Mr. Benjamin Reece is with us—and may that be long!—the tie-plate will have its earnest advocate, but the tie-plate is an essentially different device from the rail-chair.

Our English contemporary argues itself into a very contented frame of mind with things as they are, and sees no probability of any "radical changes of any kind." It is, however, more than possible that, under the impetus of increasing speeds and weights of rolling-stock to be moved, and increasing demand by passengers for greater comfort, the 'drift of opinion' which it now notes will set into a steady current, upon which an adapted form of the American plan will be carried into Great Britain.

Light Railways and Electric Roads.

An American reader of British and continental exchanges can hardly fail to be impressed with the amount of space devoted to the discussion of light railways, and the possible importance of the subject in the United States.

Properly used, the term designates a comparatively short feeder line, usually, though not by any means always, of narrow gage; necessarily of cheap construction; adapted only for light rolling stock and loads approximating four tons per axle; intended to tap agricultural or mining districts lying back from the main line, and to replace wagon-hauling in bringing down freight or passengers to the stations.

If such a line be wisely located, it seems to promise valuable returns to the promoters, who would receive the returns for moving the traffic formerly carried at much greater expense by wagon; to the residents and shippers of the region, who would find the new mode of transportation a gain both in convenience and economy; and to the main railroad, which would certainly receive an increased business from the greater advantages afforded for the moving of mine and farm products.

In practice the results have been widely variable, and the diverse experience gained in different localities is reflected in the wide diversity of attitude toward these enterprises displayed by different writers.

A very valuable collection of data and statistics is contained in Mr. J. W. Mackay's "Light Railways for the United Kingdom, India, and the Colonies," which is reviewed by *The Builder* (London). Mr. Mackay finds the system so successful on the continent (notably in Belgium, Hungary, Prussia, and France), in South America, and in India, that he is inclined to advocate strongly its expansion in England; but the reviewer in *The Builder* dissents from this position, basing his unfavorable judgment upon the poor average returns of existing lines and the unpropitious conditions which, according to his view, exist generally throughout England.

It is the recital of these adverse conditions which suggests the contrast afforded by those existing in our country. Says *The Builder*: "The study of the railway map of England shows how very few towns, or indeed villages, now remain which are as much as eight miles from a station; and, even where these occur, they are situated for the most part in non-agricultural districts.

"Thus, for the most part, any new light railway which can be proposed is so cramped and hemmed round by existing main lines that its area of usefulness is curtailed to an extent that prevents any individual line from being more than ten or twelve miles in length.

"Of this already too short a distance, the first two or three miles can not be regarded as augmenting the goods traffic or helping the farmer, as he will prefer for economical reasons, to cart his goods direct to the main line." Of course, the natural effect is the curtailment of the possible business below the limit which will support an independent staff of officers, pay the running expenses, and leave any margin for dividends.

Furthermore, the reviewer finds in the hundreds of horse-drawn wagons which nightly deliver their loads of garden produce to London markets, from distances as great as twenty to twenty-five miles, an eloquent object-lesson on the subject of railway rates and transfer.

Lastly is urged the impossibility of cheap construction, owing largely to the high cost of land.

These very objections suggest the antithesis to be found in American conditions. Our land of magnificent distances affords many areas still remote enough from main lines of railway to make haulage burdensome and almost prohibitory; our wagon-roads, often execrable, are seldom so good that a twenty to twenty-five mile haul in competition with movement by rail is practicable; railway rates considered remunerative here are far below English figures, and land generally has not attained so high values as on the other side.

Yet, unless a few mining and lumber roads be considered as embodying a similar idea, the light railway has received little attention in the United States.

For passenger traffic, it is true, "the trolley" is rapidly pushing its way into prominence; but, to anyone familiar with the situation of vast numbers of agricultural communities in the middle west, it seems really extraordinary that so inferior and expensive haulage facilities have been so long tolerated, and that at least the extension of electric traction to freight movement is so tardy and so sporadic in its appearance.

An inordinate amount of attention has been attracted to the electric road as a rival or supplanter of the steam railroad; little has been said of its more probable and natural functions as an auxiliary and a feeder. The Lake Shore road is said to have discovered already that suburban electric lines, at first injurious to their traffic, soon induced a large increase therein.

Why would not the same conditions be developed even more strongly and advantageously in freight traffic, when the managers of electric lines realize their opportunity and develop from them the American light railway?

Antiquated Yard Management.

An important, but apparently badly neglected, field for improved railway methods is briefly suggested by Mr. D. S. Sutherland in a recent contribution to the *Railway Review*,—the handling of freight trains at terminal points and in yards.

The wonderful advance which has swept along the main line, transforming almost every detail of way, equipment, and service to conform to standards scarcely dreamed of fifteen years ago, has apparently left the side tracks almost untouched. To quote Mr. Sutherland: "Freight trains are rushed over hundreds of miles of road only to be delayed in terminal yards or at interchange points. It takes longer on most railroads to get a car from the warehouse to the point where it is to be made up in a train ready to start on its journey than it does to run the train a hundred miles; and then at the terminal it takes still longer to get it to the warehouse or connecting line."

"A great deal is said about our great double- and four-track railroads, but I hold that a good single-track railroad, with properly-equipped yards and warehouses, is capable of better results than one with any number of main tracks and poorly-equipped terminals.

"My idea of a railroad is one that has warehouses where freight can be taken from the consignor and loaded into cars, or taken from cars and delivered to consignee, with the minimum amount of handling and the least loss of time; and one that has yards where cars can be properly drilled out and grouped together at one point, and thus save switching at other points,—yards where the first cars to arrive are the first cars to leave. With very few exceptions, railroads are doing their switching the same as it was done when steam railroads first came into existence, and it costs these roads more to get a car through their yards than over any one hundred miles of their line.

"In the first place, a train arriving pulls in and occupies a track in the distributing yard, and, if several trains are in company, a track is occupied by each one, and no switching can be done until the whole fleet has arrived, and is gotten out of the way, and the chances are that then this yard is blocked, so as to render switching to any advantage almost impossible. A switch engine takes hold of the train, and the first move is to pull the train back out of the yard, and, for every cut that is made, the whole or greater portion of the train must be handled, with the result that draw bars are pulled out or broken and cars receive much more damage than they will receive on a trip over the whole line.

"Railway companies have come to realize that, in order to meet competition, it is necessary to reduce grades, increase the capacity of engines and cars, and in every way possible reduce the cost of transportation; but they do not as yet seem to realize that, in order to make this a success, it is necessary to equip their stations and terminals so as to meet the improvements in other quarters. If the capacity of freight engines is increased, it is just as necessary that the capacity of the yard be increased in proportion.

"I know of no place where there is such a chance for reduction of cost of handling as at terminals. In order to accomplish this, yards need not necessarily cover any larger territory, but they can be so laid out that the switching can be done properly and thoroughly, without loss of time or waste of power, and thereby a large reduction in cost and far better results may be arrived at. What is true of yards is also true of warehouses, meeting and passing tracks, and all other transportation facilities."

Mr. Sutherland's paper perhaps conveys too scanty a recognition of the reforms already inaugurated in laying out and managing yards; but that very much still remains to be done is only too keenly apparent to shippers and consignors,—perhaps even more to them than to railroad men.

Blank Drivers on Locomotives.

A RATHER remarkably complete abandonment of ideas once firmly fixed and unhesitatingly accepted is evidenced by the discussion following the reading, before the New York Railroad Club, of Mr. Molineux's paper on the use of blank drivers on locomotives.

It was formerly almost, if not quite, the universal practice, when an engine had more than two pairs of drivers, to have one or more with blank tires; sometimes even the eight-wheel engine had one pair of drivers blank; and yet, as Mr. Molineux says, such importance is attached to the integrity and perfection of tires in every other situation that the burden of proof should be upon those who advocate the omission rather than upon those who plead for the retention of the tire.

"The supposed advantages of blank drivers," he says, "so far as I have been able to learn them, are less strain on the track in passing around curves, the avoidance of flange friction on curves as to the pair of blank drivers, and less strain on the engine generally."

As to the first count, however, he finds the evidence of roads using all flanged drivers to be that engines so built are no harder on the track than those with one pair blank.

As to the second, the avoidance of flange friction on the blank drivers is naturally conceded, but the argument made that the tendency of the engine to travel off at a tangent is in no wise reduced, and the work of resisting it is simply increased for the remaining flanges. The third and last count is distinctly negatived by the fact that "the riding qualities of an engine are certainly improved by using all flanged drivers."

Mr. Molineux shows that there is really no danger of the track being too tight, as an engine with a 16-foot wheel base standing on a 20-degree curve would still have (on account of the ordinary widening of gage for such a curve) a clearance of ¼ inch, as against ⅜ inch on a tangent, without allowing anything for side-play allowed in building the engine.

On the other hand, the argument for the all flanged construction is supported by many excellent claims. Practice shows that it results in fewer derailments; a crippled engine can be more readily replaced on the rails and taken to the shop in a crippled condition; the flanged tire is stronger than the blank, as well as cheaper; the engine will make more mileage with fewer sharp flanges; a smaller stock of duplicate parts is required, and more tractive power is secured because the flange keeps the effective portion of the tire more truly on the rail. And, not least, the greater confidence inspired in the enginemen results in better running and a closer adherence to time. All of these contentions Mr. Molineux supports with effective concrete instances.

The blank tire proved to have its adherents still,—some of them strong and important ones. The Pennsylvania Company practice is to have blind tires on the second and third pairs of drivers on their consolidation locomotives, and they seem well satisfied with it; but the majority was strongly with Mr. Molineux. As Mr. Sinclair remarked, the subject comes up about every second year in the Master Mechanics' Association, "and it is remarkable to find how gradually all the members have been changing in favor of flanged tires."

The Traveling Engineers' Association.

THE spirit of association, to which Mr. Ingalls refers with strong commendation in the July number of THE ENGINEERING MAGAZINE, seems to pervade most happily the entire railroad organization, with resultant general benefits whose extent could hardly be measured.

The notion that another's loss must be our gain, once an axiom of statesmanship, is rapidly dying out as a directing influence in national and commercial affairs, but nowhere has it disappeared more completely than in the railroad world, especially in the operating and mechanical departments. Officials of every rank realize that they can gain from others in intercourse immeasurably more than they give, and that a good thing is none the worse for being imparted to those who can appreciate it and return it, enlarged and improved, to its originator.

One of the most commendable of these friendly and profitable organizations is The Travelling Engineers' Association, which, though it is approaching the completion of its fourth year only, has abundantly established its value, not only to its members, but to the railroad service generally, and has won the hearty recognition of officials throughout the country.

It began Nov. 13, 1892, with a concerted meeting of fourteen traveling engineers, or road foremen of engines, who came together for the purpose of considering the possibility and advantages of a permanent organization. The outlook seemed favorable, and the first regular meeting took place in New York on January 9, 1893, organization being then effected, constitution and by-laws adopted, and the subjects assigned for discussion at the first annual meeting, which was held in Chicago.

From an original membership of 53, the roll has increased to 180, representing about one hundred of the most important American, Canadian, and Mexican lines. The active membership is composed of practical men, who have grown up from the ranks, the eligible classes being travelling engineers or those who have advanced from that rank to a higher one, experts in air-brake practice, general foremen, and round-house foremen who have been locomotive engineers. All whose knowledge of locomotive management may be of service and value to the association are eligible as associate members.

The object and aim of the association is "the improvement of the locomotive-engine service of American railways through the advancement of knowledge concerning the duties of traveling engineers, by discussions in common and exchange of information on subjects interesting to its members, thereby making the work in all branches more systematic and efficient for members and more profitable to the railroads."

The subjects discussed by the association have been noteworthy for their lively interest and close relation to the practical and economical service of our railways; many of them are among the most important now being considered in the railway world.

The next annual meeting will be held at Minneapolis on September 8. Some of the topics proposed are: "Could not the locomotive service of the country be improved, if the furnishing of feed-water and coal were in the hands of the locomotive department?" "Would the rating of engine loads by tons instead of by cars decrease train delays and increase the efficiency of the power, and what is the best method of equalizing the difference between empties and loads?" "Standard forms of examination of firemen for promotion and of new men for employment," and "The proper operation and care of and instructions concerning sight-feed lubricators."

The circulars of inquiry issued by the committees in charge of the various topics display the breadth and thoroughness with which the discussions are undertaken. The association certainly seems destined to wield an excellent influence, and merits the cordial approval and coöperation of the higher officials.

ALTHOUGH we in this country are supposed by our English cousins to be hopelessly joined to our railway idols, we must admit that the English railways show a consideration for the convenience of special patrons which might well be recommended to our passenger department, the I. S. C. Law permitting. One of these, to quote *The Engineer*, is "an arrangement for special tickets for members of golf clubs"; another is "the issue of week-end return tickets, at about single fare, for the use of commercial travelers" returning home to spend Sunday. A third, recently mentioned, is a return ticket good going from A to B and returning from C to A, the distance from B to C being over some scenic district tempting to bicyclists. Such a recognition of healthy amusements is good both ethically and financially.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Railroad and Engineering Journals—See Introductory.

*6504. The Turning Point in Railway Reforms. M. E. Ingalls (Showing that rate-agreements and the abolition of rate-cutting mark a new era in railroading). Eng Mag-July. 2700 w.

*6513. The Great Western Railway Company's Latest Express Engines (A descriptive account with photographs, dimensions, and some figures of performance). Ry Wld-June. 700 w.

*6514. A Belgian Light Railway (The article gives general features of construction and equipment, with map of the road and terminals and drawings of rolling-stock). Ry Wld-June. 1100 w.

*6515. Manganese Steel Points and Crossings (Recommending manganese steel for positions of heavy wear and alleging American experience in support of the practice). Ry Wld-June. 700 w.

†6516. Agabey's System of Repeating Signals between Stations and Trains in Motion (This is an adaptation of electro magnetic signalling by which the position of the home signal is shown by an indicator on the locomotive of an approaching train. It is hardly applicable to American practice). Ind Engng-May 9. 900 w.

6518. The Efficiency of Compressed Air for

Street Car Motors. Robert Lundell, with Editorial (The object of the paper is to correct erroneous impressions, and deals only with efficiency). Elec Eng–June 10. 2000 w.

6533 New Freight Cars for the Baltimore & Ohio R. R. (Gives dimensions and abstract of specifications for a large order of freight cars). Eng News–June 11. 1100 w.

6538. Urban Growth and the Electric Railway. Louis Bell (A discussion of the influence of improved street traction on the enlargement of a city. Boston is the typical instance used as an illustration. A map shows the enlarged time-radius). Eng News–June 11. 2700 w.

6541. Railroad Earnings in May (Summary and groupings of earnings and mileage for May, and for five months, with comparative figures of same periods in 1895). Bradstreet's–June 13. 800 w.

*6542. Railways in Asiatic Turkey (Reviews the present construction and future possibilities. The situation is described as peculiarly Turkish, and not very encouraging to European capital). Eng, Lond–June 5. 2300 w.

*6543. The Dalmuir and Clydebank Railway (Descriptive of construction of a short railroad presenting peculiar difficulties in the crossing of a canal and of other roads). Eng, Lond–June 5. 1300 w.

*6545. Permanent Way (Editorial review of the distinctive characteristics of American and English practice, favorable in tone to the latter). Eng, Lond–June 5. 2000 w.

6546. Economical Use of Large Freight Cars (Report of the Committee on Official Classification and Large Cars, C. H. Bieber (Mich. Central), Chairman, read at the Convention of the International Assn. of Car Accountants at Cleveland (Condensed). The striking feature is the recommendation of a radical change in the reduction of present minimum weights for many classes of freight). R R Gaz–June 12. 1200 w.

6547. 80,000-lb. Ore Car for the Erie Railroad (A very full description, condensed from specification, with dimensional and sectional drawings). R R Gaz–June 12 1400 w.

6548. The Pennsylvania Railroad Voluntary Relief Department (Gives in brief form the chief principles upon which the plan is formulated). R R Gaz–June 12. 1100 w.

6549 Emergencies in Railroad Work. L. F. Loree (Extracts from a lecture delivered before the students of the College of Mechanics and Engineering, University of Wisconsin. Treats of wrecks, washouts and strikes, and the preparations which can be made for dealing promptly with such events). R R Gaz-June 12. 3600 w.

*6550. Heating Carriages on the Eastern Railway of France (The first number reviews the crude and unsatisfactory methods still largely in vogue, and describes the Lancrenon steam-heating apparatus, and diagrams. It affords an interesting comparison with American practice). Engng–June 5. Serial. 1st part. 3000 w.

*6552. The Dublin Electric Tramway System (The first number is devoted principally to the power system, with map of the route and plan of power station). Engng–June 5. Serial. 1st part. 2500 w.

6564. The Safety Appliance Act, and Automatic Couplers (Editorial advocating a broad interpretation of the law and prompt compliance with it). Ry Mas Mech–June. 1000 w.

6565 M. C B. Coupler Attachments (A review of the inferior design and workmanship of many devices now in use or proposed) Ry Mas Mech–June. 1100 w.

6566. The Inspection of Air Brake Hose (A plea for greater care in determining the cause of damage and failure). Ry Mas Mech–June. 1200 w.

6567 Sixty Thousand Pounds Furniture Car, Chicago, Great Western Railway (A large car carefully designed to exclude superfluous material. Partial drawings and dimensions). Ry Mas Mech–June. 1400 w.

6568. New Fast Passenger Locomotive, C. R. I. & P. Ry. (Dimensions and partial drawings with brief descriptive account). Ry Mas Mech–June. 300 w.

6569. Twenty Years of Railways. Horace R. Hobart (A review of the last two decades, with statistical tables and graphic charts of construction, mileage, financial condition, etc, with editorial). Ry Age–June 13 6200 w.

6570 Feed Water Purifying (A symposium of replies from important roads, to a circular of inquiry as to experience and methods tested). Ry Age–June 13 6800 w.

6581. Relations Between Boilers, Cylinders and Weight on Driving Wheels of Locomotives. Maurice Demoulin (From the Bulletin of the International Railway Congress. The first number is concerned chiefly with discussion of the ratio of grate and heating surface, to adhesive weight in various typical European and American locomotives, of which data are given in tabular form. Some space is given to forced draft, fuel, and the contrasting preference for power and economy respectively in American and European practice). Ry Rev–June 13. Serial. 1st part. 2200 w.

6582. The Depew Shops—N. Y. C. & H. R. R. (Gives a brief description of plan and equipment, with plat and exterior and interior views) Ry Rev–June 13. 1000 w.

6620. Progress in Adopting Safety Appliances in Railway Equipment Edward E. Moseley (A statistical article showing the percentage of total equipment already fitted, and reviewing existing and pending legislation). R R Car Jour–June. 1300 w.

6621. Efficiency of Foundation Brake Gear. R. A. Parke (Criticises the defective design of freight car trucks from the point of view of brake efficiency, and advocates a higher maximum braking force, and inside hanging of brakes). R R Car Jour–June. 1200 w.

6622. Facts Going to Waste. George S. Hodgins (A plea for the collection of data by car inspection and other departments, in the interest of valuable general conclusions). R R Car Jour–June. 2500 w.

6623. Compressed Air in Car Shops. William Apps (A discussion of compresser efficiency, with table of cost per lift according to cylinder, area, and maximum weight). R R Car Jour-June. 1600 w.

6624. Art in Car Building. Duane Doty (A summary of modern practice in interior and exterior finish and decoration, based on Pullman standards and artistically illustrated with reproduction of designs). R R Car Jour-June. 3000 w.

6625. The "Black Diamond" Express (A good description of a recent typical American express train, with diagrams and photo-engravings). R R Car Jour-June. 450 w.

6626. Economical Oiling of Brake Cylinders (Report of Committee of Assn. of Railroad Air-brake Men. Urges necessity of uniform treatment on account of rapid increase of freight equipment, and discusses frequency of oiling, lubricants, methods and location of cylinders). R R Car Jour-June. 3000 w.

6627. Maintenance of Passenger and Freight Brakes (Report of committee at third annual convention of Assn. Railroad Air brake Men. A full discussion of equipment, valves, tools, methods, reports, etc., with illustrations of apparatus and forms for records). R R Car Jour-June. 4000 w.

6628. Car Owners' Responsibility. F. H. Stark (Largely a review of the unsatisfactory results, insufficient earnings and heavy repair charges on freight cars under the present system). R R Car Jour-June. 2800 w.

6629. The Relation of the M. C. B. Rules of Interchange and the Basis or Rate of Car Hire to Facility of Car Movement. W. W. Wheatly (An exposition of the inadaptability of present basis of payment or inspection to expediting car movements). R R Car Jour-June. 2000 w.

*6630. A Universal Sanitary Street Car (A new pattern adaptable to all weathers, and possessing many novel features). St Ry Rev-June 15. 1000 w.

*6631. Fenders, Are They Practicable? M. D. Stein (A paper read before the California Street Railway Assn. The points emphasized are the unsatisfactory results from types experimented with, the alleged increase in number of accidents when fenders are used and the need of statistics). St Ry Rev-June 15. 2800 w.

*6632. New Incline up Lookout Mountain at Chattanooga (A description of the construction, operation and safety devices). St Ry Rev-June 15. 2200 w.

*6633. Duties of Passengers to Obey Company's Rules (Digest of decision sustaining the company's right to enforce reasonable rules, and reversing a verdict awarding damage to a passenger ejected for violating such a rule). St Ry Rev-June 15. 1200 w.

*6634. Testing Drop Around Rail Joints. Franklin Sheble (The object is chiefly to urge the importance of such tests and the remedying of defects indicated thereby). St Ry Rev-June 15. 1100 w.

†6645. The Construction of a Railway Tunnel at Hamilton, Ontario, Ill. Peter Mogensen (Describes in some detail the construction of a 2000-ft., double track tunnel, chiefly through loose material, with data of quantities and cost). Tech-May, '96. 3500 w.

†6659. The Railway Transition Spiral on Old Railway Curves. Arthur U. Talbot (Methods of computation and field work for inserting a spiral between two curves, or between a tangent and a curve). Tech-May, '96. 1200 w.

†6660. Degree of Curve. William D. Pence (The single chord, short chord and arc definitions are discussed, differences between respective radii for all degrees tabulated, and formulæ for sub chord correction and determination of radius, and excess of arc over chord are deduced and graphically illustrated). Tech-May, '96. 1400 w.

†6669 Block Signalling (Notes on a lecture delivered by George W. Blodgett. Treats very briefly absolute and permissive blocking, running trains by telegraph and signalling in yards). Trans Assn of Civ Engs of Cornell Univ-June, '96. 1400 w.

6673. The Bridge Disaster at Victoria, B. C. (A review of the accident and the causes as deduced from expert investigation; with views of the wreck and rotten bridge members, and strain sheet). Eng News-June 18. 3000 w.

6674. Railway Yards and Terminals. W. L. Derr (A thorough and able discussion of governing principles of design and practice, track arrangement and usage, switching, electric communication, lighting, signalling, and location of yard accessories, with plan and diagrams). Eng News-June 18. 4800 w.

6675. The Construction and Operation of Railway Yards (Sums up certain general principles and calls attention to the inadequate consideration too often given the matter in the country). Eng News-June 18. 1700 w.

6676. Burnside Shops, Illinois Central R R. (The first number treats of the general plan of the shops and connected yard, sewerage, drainage, lighting, water supply and minor yard features, and also of the buildings, with dimension and construction details). Eng News-June 18. Serial. 1st part. 3500 w.

6677. Twelve-Wheel Locomotive; St. Lawrence & Adirondack Ry. (Brief description with details of dimensions). Eng News-June 18. 500 w.

6680. New Eight-Wheeled Locomotive of the Boston & Maine. (A very full description with dimension drawings of details, and indicator cards). R R Gaz-June 19. 2800 w.

6681. Comparative Efficiency of Pintsch and City Gas (Abstract of report by Mr. P. H. Brangs, Electrician of the D. L. & W. R. R., showing results extremely favorable to Pintsch). R R Gaz-June 19. 1200 w.

6682. The Master Car Builders' Convention (Abstracts of a number of reports and partial list of exhibits. Some of the important topics are metal under framing for freight cars, freight car doors and attachments, mounting wheels, stenciling of cars, handholds and height of drawbars, location of air-brake cylinders, supervision of standards, &c). R R Gaz–June 19. 1000 w.

6683. The Work of the Brake Shoe Test Committee (Editorial review of the committee reports, with diagrams and tables). R R Gaz–June 19. 2200 w.

6684. Supreme Court on the Separate Car Law (A review of Justice Harlan's dissenting opinion. The review severely criticises the law). R R Gaz–June 19. 1100 w.

*6686. Recent Improvements in Maintenance of Way. Benjamin Reece (Considers ballast, ties, rail and fastenings from the point of view of necessity of excellence imposed by competitive struggle for business). Jour Assn of Engng Socs–May. 5000 w.

6758. The Progress of American Car Construction. H. S. Haines (Address delivered at the Master Car Builders' Convention, reviewing the rapid improvement in comfort and safety and the wide field still open to inventive genius). Ry Rev–June 20. 3200 w.

6759. Annulling Part of a Train Order. J. F. Mackie (A paper read before the National Assn. of Train Dispatchers, urging propriety and convenience of the proposed amendment of Am. Ry. Assn. rules permitting a particular movement to be superseded). Ry Age–June 20. 2000 w.

6760. The Johnson-Lundell Railway System (Describes a short surface-contact line, with description of the operation of the system, photographs and diagrams. Gives little information as to practical success). Elec Eng–June 24. 1800 w.

6762. Electric Heating. Edward Puchta (Abstract of paper read before the Chicago Elec. Assn. Deals principally with car heating). Elec Eng–June 24. 1800 w.

†6763. The East Coast Railway of India (Describes chiefly the points of importance reached by the line. The chief object is to secure the pilgrim traffic to the shrine of "Jagannath," with map). Ind Engng–May 16. 1400 w.

6764. Standard Track of American Railways (An important and valuable compilation of the standard practice of 53 chief American roads as to every important item of track construction, given both in the form of descriptive notes and in a well arranged table. With editorial). Eng News–June 25. 9700 w.

6766. Annual Convention of the Railway Master Mechanics' Association (A condensed report of the meeting at Saratoga, with short abstracts giving the conclusions of committee reports on exhaust pipes, balanced valves, reciprocating parts, cylinder bushings, hub liners, steam pipe joints, and the safety of radial stay boilers). Eng News–June 25. 2700 w.

6773. Axle and Journal Box for 80000 lb. Cars (From the M. C. B. Committee report. An extensive abstract giving formulæ for dimension calculations, discussion of stress and breakage, friction and lubrication in the journal, specifications and test). R R Gaz–June 26. 5200 w.

6774. The Tramps and the Railroads (Editorial, reviewing the danger from the tramp class, and accidents traceable to them). R R Gaz–June 26. 1000 w.

6775. May Accidents (A classified table, with comparison with the same month in the five previous years). R R Gaz–June 26. 500 w.

*6777. Express Passenger Engine, Boston and Albany Railroad (Descriptive specifications are given with indicator diagrams, sectional drawings of cylinder and valve, and comment on the peculiarities and merits of the Fay Richardson valve). Eng, Lond–June 19. 1000 w.

*6779. A New Lubricant for Railway Axles (Gives some phenomenal comparative figures from tests on the Prussian State Railways, but no hint as to the composition). Eng, Lond–June 19. 800 w.

†6781. Tool Rooms in Machine Shops (Committee report before the Western Railway Club, embodying recommendation as to selection and arrangement of tools in the room, and regulations for the issuing of tools and their use by workmen. With diagrams). Pro of Cent Ry Club–May. 1400 w.

†6782. Air-Brake Testing and Inspecting Plants (Discussion in the Western Railway Club, of committee report presented at the preceding meeting, devoted chiefly to compressors and pumps, and the time necessary for testing trains properly). Pro West Ry Club–May. 7800 w.

6783. 19 vs. 31 Train Orders. Harry B. Ware (Read before the annual convention of the Train Dispatchers' Association of America. Arguing for the use of the 19 order in place of the 31, on account of the frequent and sometimes annoying delays occasioned by the requirements of the latter). Ry Age–June 27. 1000 w.

*6787. Light Railways (Discussion of a book by J. C. Mackay on "Light Railways for the United Kingdom, India, and the Colonies." The review questions the advantages of light railways under the conditions existing in England). Builder–June 20. 2000 w.

6800. Electrical Operation of the Lake Street Elevated Road, in Chicago (Description of construction and equipment under the third rail system, with photographs of structure and drawing of third rail connections). W Elec–June 27. 1200 w.

†6814. Is It Good Practice to Use Blank Drivers on Locomotives. L. E. Molineux (Paper before N. Y. R. R. Club, strongly favoring flanges on all drivers, claiming fewer derailments, easier replacement and movement of cripples, greater strength and tractive power, more mileage and minor advantages. Discussion in accord with the paper). N Y R R Club May 21. 9400 w.

6815. Illinois Central Lake Front Improvements (An account of an important piece of improvement, with plan of the tracks before and after the alterations). Ry Rev–June 27. 1100 w

6816. The Reports of the Master Mechanics' Association (A summary of reports on exhaust pipes and steam passages, thickness of engine truck wheel flanges, cylinder bushing, and driving box wedges, with editorial). Ry Rev–June 27. 10000 w.

6848. Elmira Street Railways (Brief illustrated description of power house, line construction and equipment). Elec Wld–July 4. 2300 w.

6851. The Outlook for the Electric Railway. F. C. Armstrong (Read before the Canadian Elec. Assn. Reviews development of the past decade, discusses the suitability of the electric railway to replace the "light railways" of Europe, and the probability of electric traction being adapted to trunk railroads). Elec Rev–July 1. 1800 w.

6869. From the Mountains to the Sea (Account of a projected outlet from the central states to tide water from which great things are expected). Mfrs' Rec–July 3. 1800 w.

6870. The Salt Lake and Mercur Railroad. W. P. Hardesty (Map, photographs and description of the line and equipment). Eng News–July 2. 1600 w.

6872. The Construction of Steel Cars (Editorial on the report of the M. C. B. Association committee. The introduction of steel is considered inevitable). Eng News–July 2. 2400 w.

6875. Ohio State Law Regulating the Interlocking of Railway Grade Crossings (Text of the bill just passed, with editorial). Eng News –July 2. 900 w.

6877. The Guatemala Northern Railway (Short historical sketch, with map, profile, brief description of the line and the train service). Eng News–July 2. 500 w.

6882. A Record Run from London to Paris. J. Pearson Pattinson (The time is given in detail, the run being made in six hours and a half). R R Gaz–July 3. 800 w.

*6883. The Eastern End of the Great Siberian Railway (A summary of progress on the several divisions, with many photographs along the lines). Loc Engng–July. 350 w.

*6884. Postal Car—Erie Railroad (Description, drawings of construction and photographs showing interior arrangement). Loc Engng–July. 700 w.

*6885. About Hot Boxes (Attributes the trouble generally to rough and inferior construction). Loc Engng–July. 600 w.

*6886. A Simple Method of Testing Railroad Signal Lamps. T. A. Lawes (Reviews progress in perfecting lenses, position of flame and protection against wind, shocks and overheating, with simple tests for photometric and other qualities). Loc Engng–July. 1200 w.

*6887. New Express Engine on the Great Western Railway, England. P. J. Cowan (Dimensions and performance of a recent English express locomotive; with photograph). Loc Engng–July. 600 w.

*6888 Diversity of Rolling Stock Details (Recommending extension of standardization to smaller parts, especially of locomotives). Loc Engng–July. 900 w.

6889. A Plea for the Little Roads. C. O. Scranton (Read at the Car Accountants' convention. A review of the disadvantages imposed on small roads in the way of undue operating expenses, and especially of inadequate proportion of revenue and oppressive treatment from through lines. Recommends their encouragement as feeders). Ry Age–July 3. 2000 w.

†6902. Return Circuits of Electric Railways Charles Hewitt (The cause of electrolysis; the various devices that have been suggested for overcoming the trouble). Jour Fr Inst–July. 3000 w.

*6904. Continuous Railway Brakes (An editorial comparing the automatic vacuum and Westinghouse systems, to the advantage of the former). Engng–June 26. 800 w.

†6914. Electric Railway Construction in Germany. Louis J. Magee (A general review of German systems of finance, construction, equipment and operation). St Ry Jour–July. 5000 w.

†6915. Studies in Economic Practice. C. B. Fairchild (Describes shop methods, tools and devices of the Chicago City Railway) St Ry Jour –July. Serial. 1st part. 4000 w.

†6916. Correct Location of Trolley Wire on Special Curves Charles A. Alden (Describing a simple mechanical method with diagram). St Ry Jour–July 400 w.

†6917. Mileage, Long Distance Riding and Transfer Systems in American Cities (A summary of the situation in thirty-eight important cities, with editorial). St Ry Jour–July. 2200 w.

†6918. Steam Piping for Electric Railway Power Plants. George H. Davis (A discussion of various methods of installation, with their comparative merits. Cuts, and a suggestion of a new system). St Ry Jour–July. 4500 w.

†6920. American Street Railway Investments (The combined operating statistics of 241 properties. The companies are divided into three groups, giving figures for four years, three years, two years and one year respectively). St Ry Jour–July. 1800 w.

6959 New York State Civil Service Examination for Electric Railroad Experts (Questions used in the examination just held). Elec Eng–July 8. 500 w.

6967. Recent Improvements in the Albany Street,-Railway Power House (Advances in engineering worthy of study). Elec Wld–July 11. 700 w.

6970. Steep Grades on Electric Railways. S L. Foster (Extract from a paper read at the first annual meeting of the California Street Railway Assn. Chiefly a discussion of the comparative merits of running motors in series and in multiple, with a strong leaning in favor of the former). Eng News–July 9 2500 w.

6973. Railway Yards and Terminals. T. Appleton (A review of Mr. Derr's article on the subject commending his principles but questioning the practicability of his plan). Eng News–July 9. 2000 w.

6977. Prospects of Railway Construction and for Manufacturing in China (A reprint of a report by Minister Charles Denby, predicting great expansion of railroad and industrial enterprises in China). Eng News–July 9. 1000 w.

SCIENTIFIC MISCELLANY

The Wind Storm at St. Louis.

THE after-effect of this storm upon the scientific world has been to impress the truth that we know scarcely anything about the tremendous discharges of energy called tornadoes, and that their results differ materially from those of the specific category of causes hitherto assigned. Something we know of the motion of the air currents during the progress of such storms, but even this knowledge may prove surprisingly small in the light of knowledge yet to be gained. In view of the meager data we now possess, many of the effects appear altogether anomalous. An account of these by Mr. John C. Barrows, an eye-witness, with engravings from photographs taken on the spot, in *Scientific American* (June 27), shows that hitherto-entertained theories are inadequate explanations of what goes on in the central tracks of these terrific scourges. A wild, resistless energy tending to overwhelming destruction,—that, in sum, is about all we know of the character of a storm like that which devastated St. Louis.

Two apparently contradictory conditions appear to have attended the progress of the storm,—to wit, excessive unbalanced pressure upon exterior surfaces, and excessive unbalanced pressure upon the interior surfaces of buildings. Whether these conditions rapidly succeeded each other, or whether they bore a constant relation of position with the central axis of the storm, is not positively known, but there are indications that changes in these conditions were sudden; that buildings subjected to great pressure upon the outside were suddenly and unaccountably relieved of exterior pressure, thus leaving the doomed structures stuffed with air at a pressure considerably above the normal, while the exterior pressure fell below the normal atmospheric pressure. In no other way can even a plausible theory be framed to account for some of the destruction shown by these photographs. Fronts of buildings forced *out*, not in; glass windows shivered and the glass heaped *outside*, not on floors inside; roofs lifted off, and dropped at a distance; east walls and west walls, *in about equal number*, thrown down *in the same district*,—these are some of the curious features of the wrecked buildings which indicate a force acting from within toward the outside.

Mr. Barrows tries to account for these singular effects by supposing an exterior partial vacuum to have been suddenly formed. The results certainly resemble those of explosions in many instances, but they could not have occurred by reason of an exterior vacuum, unless this was almost instantaneous in character. A very short time would, in the majority of cases, permit the equalization of exterior and interior pressure, as crevices around doors and windows, chimneys, and ventilating flues would prevent the air from exerting an inside unbalanced pressure, unless the exterior partial vacuum be supposed to have formed almost instantaneously. And, if so formed, what formed it? It seems useless, until investigation reveals something now unknown of the causes which generate these intense local storms, to speculate much upon the matter. It is time that persistent scientific research were directed to the subject. It may be found that atmospheric electricity plays an important part.

In a certain area which Mr. Barrows calls the "vacuum district," the havoc was most conspicuous in buildings having few openings to the exterior.

With reference to some other phenomena, it is apparent that, if they were produced by the mere velocity of wind, our ideas of the velocity that winds may attain have hitherto been very far short of the reality. A pine board was driven through a ¾-inch iron plate and left sticking there. One hundred miles per hour has been regarded as almost a maximum wind velocity,—in other words, a velocity per second of about one hundred and nineteen feet. Can it be supposed that such a velocity could project a piece of soft pine through an iron plate? Such an effect might be expected with a velocity generated by a discharge of a rifle,—say, two thousand feet per second. It is plain that, if wind alone is to account for facts of this kind, we must remodel our conceptions of its maximum velocity.

That vacuum effects were produced can not be doubted. The sudden lifting of the gas tank in Gratiot street, vouched for by the superintendent of the works of which it was a part, shows that either exterior pressure was suddenly reduced, or interior pressure was suddenly increased. Perhaps both these things happened simultaneously. Nothing in the nature of the case suggests the probability of a sudden increase of pressure in the contained gas. The only alternative is the supposition that the barometric pressure upon the outside became suddenly so much less than normal as to leave the pressure of the confined gas in excess. The fact that areas of partial vacuum were generated is not doubted. It is, however, possible to conjecture that some other force, either unknown as a force, or, more probably, manifesting itself in an unknown way, is the underlying cause, not only of the great atmospheric disturbance, but also of the movements of other bodies exposed to its influence. We shall not be the first to think it not unreasonable that great discharges of repulsive force may issue from the earth's surface, although this has never yet been satisfactorily demonstrated. May not certain conditions yet undreamed of be concerned in the production of tornadoes?

Limitations of Scientific Knowledge.

"BUT, when I think how infinitely little is all that I have done, I cannot feel pride; I only see the great kindness of my scientific comrades, and of all my friends, in crediting me for so much. One word characterizes the most strenuous of the efforts for the advancement of science that I have made perseveringly during fifty-five years; that word is failure. I know no more of electric and magnetic force or of the relation between ether, electricity, and ponderable matter, or of chemical affinity, than I knew and tried to teach to my students of natural philosophy fifty years ago in my first session as professor. Something of sadness must come of failure; but, in the pursuit of science, inborn necessity to make the effort brings with it much of the *certaminis gaudia*, and saves the naturalist from being wholly miserable, perhaps even allows him to be fairly happy, in his daily work."

The above quotation from a speech of Lord Kelvin, in reply to a toast on the occasion of the recent jubilee held in honor of the fiftieth year of his professorship in Glasgow University, voices a sentiment the force of which can be appreciated only by men who, like himself, are nearing the close of life. It can be fully appreciated only by men who have devoted themselves to scientific research. Entering upon a field having no boundaries, the realization of its vastness and the utter hopelessness of the search for the ultimate grow upon them constantly, until their entire stock of knowledge seems to dwindle into a mere infinitesimal in comparison. The littleness of man, the restrictions which environ his intellect, the suspicion that there are active forces and causes yet undiscerned of which, from their very nature, he can never know anything except by inference,—these and other considerations so force themselves upon the true scientist that pride in his work is mingled with humility, as he reflects upon what he has been able to do, how much there is yet left for others to do, and how much can never be done by human effort.

The greatest scientific men have thus been simple, unassuming men. The tendency of their pursuits is to make them a class apart. The love of truth becomes almost a passion with them. Social conventionalities are false and hollow, and what is called "good form" matters little to men whose thoughts rarely descend to conventionalities. Hence in manners and dress they are apt to be somewhat peculiar, sometimes exposing themselves to personal ridicule, but, for the most part, they are entirely oblivious to it. Any one who has seen a portrait of Lord Kelvin will agree that, without knowing the man the picture represents, one might take him for a boss mechanic. There is nothing in his plain, unaffected countenance to mark him as one of the foremost of scientists, of teachers, of investigators, of inventors, now living. He is neither distinguished-looking in face or in dress; and those who have described this great man unite in portraying his manners as simple and unaffected.

His ripe age, upon which honors have fallen like leaves in autumn, has taught him the littleness of the things which men most eagerly seek; and experience has shown him how soon the majority of mankind are forgotten when they finally depart. We may well believe him when, considering all these things, and looking forward to his own departure, he utters the significant words: "I cannot feel pride."

Probable Increase of Tobacco Culture in the United States.

AN industry in the United States that seems likely to obtain an impulse from the war in Cuba is the culture of tobacco. *The St. Louis Globe-Democrat* announces the opinion that this country has now the opportunity to become independent of foreign leaf tobacco. *Bradstreet's* (June 20) reviews the article editorially, and presents facts of interest with reference to localities where good tobacco can be grown, the quality of tobacco produced in different places, etc.

"In Pennsylvania the tobacco product is large—last year 64,500,000 pounds. It has been hinted that many excellent Havanas are not very different from the tobacco of Pennsylvania, which in its raw state has been sold for six cents per pound. The peculiarity is that it is a gummy leaf. The tobacco leaf itself is the shape and size of the rubber house-plant. It grows about four feet high and bears a slender-veined leaf. In the Keystone State this leaf has a close texture and a gumminess that unfits it for wrappers, but makes it fine filler, and, it is said, could be used for the best Cuban filler in the world without fear of detection. Since the prohibition affecting the Havana leaf, the price has gone up.

"Florida tobacco product is so fine that the most careless growers can get forty-five cents a pound for it. One trouble is that there is so very little of the crop. It grows luxuriously enough, but, with foreign competition so near them, the Florida growers do not increase the acreage. Many have refused to sort their leaves, sending them helter skelter in 'running lots,' but even in this way a very nice price is obtained. Recently a certain dealer offered one dollar per pound for all the Florida tobacco he could get.

"In Connecticut a great many farmers raise tobacco. While the Connecticut wrapper is dry and tough, it has moisture enough to keep the cigar in flavor, and does not break. It is this peculiar quality in the leaf that makes it in such demand for wrapping purposes. But it is in the flavor that the Connecticut leaf excels. There is a tobacco known as 'cimmer.' It is a very good medium tobacco. It is raised in great quantities in Ohio, Wisconsin, and Massachusetts."

The *Globe-Democrat* says that "cimmer" brings eighteen cents per pound in Ohio, but less in other States. It has not paid the farmers of Illinois to raise tobacco, though, it is said, an excellent quality can be grown there. Near Corning, New York, tobacco is cultivated, and is in quick home demand. Some tobacco is raised in Vermont, which also finds a near market. Tobacco has recently advanced notably in price, and it may be a good time for farmers who are getting very low prices for other crops to consider the advisability of turning their attention to cultivating tobacco.

Electrolysis of Hydrochloric Acid.

IN *American Chemical Journal* for July, a description of a satisfactory apparatus for effecting electrolysis of hydrochloric acid, as a laboratory and class-room experiment, is jointly contributed by Mr. Geo. O. Higley and Mr. B. J. Howard. The exhibition of equal volumes of chlorine and hydrogen has hitherto been difficult and the apparatus employed has been complicated. The experimenters explain that the accuracy of their new apparatus in operation "depends upon the fact that the gases traverse but a small layer of liquid, while they are collected and measured in separate tubes, distinct from the ones which contain the electrodes. They can also be measured under diminished pressure by the use of a leveling-bulb attached to the stop-cock *c* (Figs. 1 and 2).

"In order to operate the apparatus, the small cups holding the electrodes are

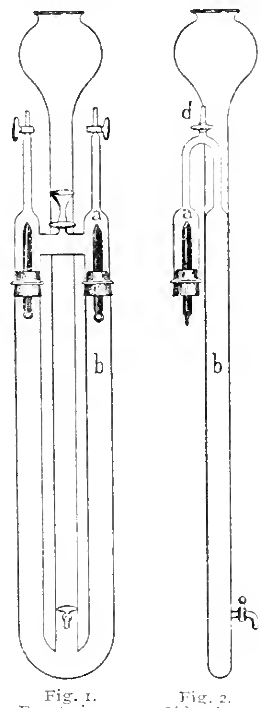


Fig. 1. Front view. Fig. 2. Side view.

filled with a solution consisting of equal parts of concentrated hydrochloric acid and water, which has been saturated with chlorine, and to which an excess of sodium chlorid has been added just previous to the experiment, the stop-cock *d* being kept open. The remainder of the apparatus is then filled with chlorine water, and, all stop-cocks being closed, the current is turned on for five or ten minutes. The apparatus is then opened, the leveling-bulb adjusted so that the liquid rises to *d*, then *d* is closed, and electrolysis carried on under increased or diminished pressure. The results in the former case are less satisfactory than in the latter. With increased pressure from 8.5 to 9.3 cc. of chlorine are collected for every 10 cc. of hydrogen, while with diminished pressure the results are very nearly in absolute accord with theory. The gases are finally measured under atmospheric pressure."

Soldering Glass.

An item has recently appeared in a number of foreign technical publications announcing the fact of a discovery which may prove to be of industrial importance. Two different alloys, melting at not too high temperatures, have been found strongly adherent to glass surfaces. One of these is composed of ninety-five parts tin and five parts zinc, and melts at 200° C. Another, composed of ninety parts tin and ten parts aluminum, melts at 300° C. and is said to adhere to glass with great force. It is further stated that, with either of these alloys, soldering glass is as easy as soldering metals. If the glass be heated to the melting-point of the solder, with the usual precautions for preventing its cracking, a small bar of the alloy may be passed over the edges it is desired to join, and the edges, pressed together till they are cooled. will be firmly united. A wand of paper may be used to distribute the melted alloy evenly along the surfaces to be joined. Also an ordinary soldering iron may be used, as in soldering metals to metals. It is alleged that their alloys have a fine metallic luster, which, under ordinary conditions, is well retained. This being the case, it would seem that such alloys might possibly be made substitutes for the amalgam of tin and mercury used in the manufacture of looking-glasses.

The Chardonette Process for Producing Artificial Silk.

The manufacture of an artificial silk from cellulose, invented some years ago by M. Chardonette, has been long in getting commercially started in England; but it has been one of the manufactures of France since 1893. It now appears from a recent article in *Nature* that the demand for this article has so much increased as to encourage the establishment of the industry in Manchester by a new company operating under license from the patentee. The London *Times* recently had an article describing the process, which is an interesting one, with striking analogies to the process by which the silk-worm converts a plastic material into a continuous filament.

The pulp, thoroughly cleansed, and looking very much like thick gum, is put in cylinders, from which it is forced by pneumatic pressure into pipes passing into the spinning department. Here the machinery looks like that employed in Lancashire spinning sheds, except that one of the pipes referred to runs along each set of machines. These pipes are supplied with small taps, fixed close together, and each tap has a glass tube, about the size of a gas burner, at the extreme point of which is a minute aperture through which the filament passes. These glass tubes are known as glass silkworms.

The effect of the pneumatic pressure in the cylinders referred to is to force the liquid matter not only along the iron tubes, but also, when the small taps are turned on, through each of the glass silkworms. It then appears as a scarcely perceptible globule. This a girl touches with her thumb, to which it adheres, and she draws out an almost invisible filament, which she passes through the guides and on to the bobbin. Then, one by one, she takes eight, ten, or twelve other such filaments, according to the thickness of the thread to be made, and passes them through the same guides and on to the same bobbin. This done, she presses them together with her thumb and forefinger, at a certain point between the glass silkworms and the guides. Not only do they adhere, but thenceforward the filaments will continue to meet and adhere at that point, however long the machinery may be kept running. In this way the whole frame will soon be set at work, the threads not breaking until the bobbin is full, when they break automatically, while they are all of a uniform thickness. The new product is said to take dye much more readily than the natural silk. The chief difference in appearance between the natural and the artificial silk is in the greater luster of the latter. The *Times* says that the success secured by the new process in France is such that the introduction of the industry into Lancashire is expected to produce something like a revolution in trade, not only by bringing into existence a new occupation, but also by finding more work for weaving machinery in Manchester now only partially employed.

An objection to the use of this material which was made at the time the process was first announced was that it is much more inflammable than natural silk. However, it may be that this has been overcome. The substance in some respects resembles celluloid. The pulp from which the filaments are formed is a syrupy solution of cellulose.

TEN years ago there were but four tramway companies in Chicago, working a street mileage of 90 miles. To-day there are twenty-nine corporations engaged in local transportation business, operating 342 miles of street mileage. Of the four systems ten years ago, three were worked by horses, one using both cable and horses. Now there are:—Electric roads, 270 miles; cable roads, 42 miles; steam roads, 11 miles.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Scientific and Engineering Journals—See Introductory.

*6530. The Sperm Whale and Its Food. Frank T. Bullen (An extremely interesting account of personal observations upon this subject, including a description of a nocturnal combat between a sperm whale and a gigantic squid). Nature-June 4. 2700 w.

6539. The Effects of the St. Louis Tornado. Julius Baier (An examination of the affected district of interest to engineers owing to the numerous examples of the destructive power of the wind). Eng News-June 11. 1600 w.

*6551. The Penywern House Technical College, Earl's Court (Description of buildings, course of study, physical laboratory, and machine shop, with illustrations). Engng-June 5. 1700 w.

6575. Cyclones and Tornadoes. John Lundie (An attempt to coördinate natural cyclonic conditions and phenomena with knowledge of action under similar artificial conditions). Elec Engng-June. 1500 w.

*6583. A Theory as to the Cause of the Phenomena Produced by the Röntgen Rays. R. C. Shettle (The writer briefly describes his theory of the nature and cause of gravity in order to clearly show his reasons for the theory presented). Elec Eng, Lond-June 5. 1500 w.

*6585. Röntgen Ray Experiments. Oliver J. Lodge (Facts determined by continued experiments). Elect'n-June 5. 1500 w.

*6598. High Explosives H. F. Metcalf (Description of some explosives in use, giving their composition and chemical reactions when exploded, and an account of two recent explosives, Mellinite and Vixorite). Yale Sci M-June. 1700 w.

*6600. The United States Weather Bureau. E. T. Tefft (General popular description of the routine of service of observers). Yale Sci M-June. 1200 w.

6615. Salt Making. R. G. Collier (An interesting account of this industry in the Ohio Valley). Tradesman-June 15. 3700 w.

†6665. The Problem of the Tides, and the Limitations of the Present Solution of that Problem. John F. Hayford (A general study of the subject as a whole). Trans Assn of Civ Engs of Cornell Univ-June, '96. 9500 w.

*6722. The Cathode Rays Under the Influence of Strong Magnetic Forces (A brief illustrated account of the investigations of Herr Kr. Birkeland, published in the Norwegian *Elektroteknisk Tidsskrift*). Elec Rev, Lond-June 12. Serial. 1st part. 2000 w.

*6723. The Röntgen Rays (The conclusions from an exhaustive series of experiments by Battelli, throwing much light on the origin of the Röntgen rays, and their relation to the cathode rays). Elec Rev, Lond-June 12. 1500 w.

6752. A Destroying Vacuum. John C. Barrows (Illustrated description of unexplained effects of the storm on different kinds of structures, many of which appear to have been the result of an exterior vacuum). Sci Am-June 27. 1700 w.

6761. The Shape of Crookes Tubes and Degree of Vacuum for Maximum Production of X-Rays (Article communicated to the French Academy of Sciences. Illustration of the tube found superior). Elec Eng-June 24. 500 w.

6771. Experiments with the Polarizing Photo-Chronograph to Determine the Motion of Projectiles Inside the Bore of a Gun. Albert C. Crehore and George O. Squier (Experiments described which were carried out at the U. S. Artillery School, Aug., 1895, with the objects of perfecting a practical chronograph suited to the needs of the military service, and to determine the adaptability of this instrument to the study of the motion of projectiles inside the bore. Elec Wld-June 27. Serial. 1st part. 2700 w.

6801. Experiments Showing the Permeability of Metallic Salts and Their Solutions by Röntgen Rays Joseph F. Smith (Experiments, with illustrations, for the purpose of ascertaining whether the difference of permeability extends to the salts of the metals and to solutions of the salts in water). W Elec-June 27. 200 w.

6808 An Investigation with Röntgen Rays on Germinating Plants. H. J. Webber (Account of experiments). Science-June 26. 500 w.

6836 Science and Engineering. Thomas Curtis Clarke (Address at the annual convention at San Francisco, Cal, June 30, 1896. Showing the necessary relations and that they are becoming closer every day). Sci Am Sup-July 4. 3500 w.

6837. A Weather Bureau Kite. C. F. Marvin (Illustrated description of a kite used for meteorological observations). Sci Am Sup-July 4. 2400 w.

6844. On the Bleyer Photo Fluoroscope. J. Mount Bleyer (Description of an instrument which is practically an adaptation of the fluoroscope to the needs of the physician and surgeon, and consists in combining of instantaneous photography with the fluorescent screen). Elec Eng-July 1. 1600 w.

†6855. The Value of Leather Refuse. J. B. Lindsey (An account of experiments with conclusions and tabulated statements of results). Jour Am Chem Soc-July. 2000 w.

6860. The Olive. A. Taltavull (Its usefulness to mankind and interesting facts about its culture. The process of extracting oil from olives and preparing it for market is illustrated and described). Prog of Wld-July. 1700 w.

*6864. Some French Cement Works. H. K. Landis (Illustrated description of works and processes at and near Lafarge on the banks of the Rhone). Pav & Mun Eng-July. 1700 w.

†6929. The Difference Between "Islands" and "Upriver" Rubber (The value because of the lesser degree of shrinkage, better dried, the condition of cleanliness, greater yield, &c.) Ind Rub Wld-July 10. 1500 w.

†6930. The Demand for Balata and the Supply (The sources of supply and its merits as a substitute for gutta-percha). Ind Rub Wld-July 10. 900 w.

†6932. Rubber Prices and the Insulated-Wire Trade (Showing that high prices of rubber are not due to its use in the electrical field). Ind Rub Wld-July 10. 1400 w.

6949 Tesla Describes an Interesting Feature of the X-Ray Radiations (Observations made by Nikola Tesla, with bulbs emitting Röntgen radiations, throwing light on their nature and illustrating better properties already known). Elec Rev-July 8. 900 w.

6974. Obtaining the True Meridian by an Observation of the Sun. C. C. Hommann (The method herein described requires only a single observation of the sun. It is an old method, but having for a time been neglected, it appears now to be coming again into use). Eng News-July 9. 1600 w.

THE

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FREE-SILVER POISON THE CAUSE OF INDUSTRIAL PARALYSIS.

By J. Selwin Tait.

THE decision of the people of this country as to whether we shall have free coinage of silver, with all the train of evil consequences attendant upon it, or whether we shall maintain our present gold standard, is of more importance to-day than would be the fact of all Europe sitting in solemn conclave to decide whether or not it should declare war against us. And, strange as it may seem, in point of injury to the country, to its commerce, and to the individual citizen, the debasing of our currency by the free, unlimited, and independent coinage of silver would be a greater evil than even a new civil war.

And herein lies the mockery of the situation. The farmer and wage-earner, stirred by the teachings of interested men, are preparing to test the advantages or claims of free silver just as they would test the fitness of a new pair of boots. They say, in fact: There is no harm in making the experiment, and, if it does not suit us, why, we shall be no worse off than before. They fail to see that they cannot try it as an experiment any more than they can declare war as an experiment, without paying the bitter cost.

The circulation of a country resembles in every detail the circulation of the human body. A man may have a splendid framework, overlaid with such a net-work of muscles as only a Samson could boast of. His vital force may be in proportion, and altogether the man may be perfect in all his parts. You may break the man's limbs; you may mangle that superb body until every movement is excruciating agony; and yet, although the man is badly injured and must be confined to a hospital, he is the same living force that he ever was, and will, in a very short time, be as strong, or nearly as strong, as before the accident. But take that man in the pride of his strength, and inject into his veins some liquid which will impair or degrade his circulation, and you at once prostrate him and make him as helpless as an infant, worse off in reality than if he were a feeble dwarf.

And the case is nearly similar where a country's circulation has been tampered with. Macaulay, with his inimitable pen, sketches a wonderful picture of the results of the debasement of the coinage in England in the sixteenth and seventeenth centuries. He shows as no other man could that, in point of the harassment and real misery which that debasement caused, it was a hundred times more hurtful than the worst of wars, and that its effect upon commerce was that of a blight under which nothing could prosper.

It is well, therefore, that all should understand that free coinage is not a thing to be taken up, and lightly dropped if found not to our liking. Many people are deluded with the thought that, as we had it once before, there can be no harm in trying it again. And therein lies our greatest danger. Every condition is changed since that time. Silver has multiplied beyond measure, and has so cheapened itself that its market is broken down. The silver men claim that the act of 1873 brought about the fall in the price of silver,—a statement utterly at variance with facts. Instead of neglecting silver since that time, as the silver men have claimed, we have added more than half a billion of dollars of silver to our circulation, with the result that we have discovered that the more we have purchased the more we have stimulated the supply (which was already over-abundant), notwithstanding the silver men's prediction to the contrary, and their assurance that the purchases under the Bland-Allison and Sherman acts would make the silver in a dollar worth one hundred cents. Silver, after a momentary spurt, declined under these purchases, until it fell to its present figures. The fact is that the purchase of silver, under the Sherman act particularly, was like trying to pump the Atlantic ocean through a hole in the bottom of a ship. The State needed a plaster and not a pump, and it was a plaster eventually that saved the country.

It is, perhaps, needless at this stage to explain what free coinage means. The main point of this paper is to consider what its outcome will be and the classes it will affect.

Mr. Bryan does not hesitate to state that he is against the creditor class,—that he is, in fact, the advocate of the debtor. Now, who constitute the creditor class of this country? The Goulds, the Vanderbilts, the Astors, the Rockefellers, the Armours, etc.? Not at all. On the contrary, they are all heavy borrowers, and, even where they are the holders of bonds, it is usually of bonds of corporations of which they are the owners, so that they simply owe money to themselves. The creditor classes of this country are the 5,000,000 savings bank depositors who have money on deposit to the amount of $2,000,000,000; the 1,700,000 share-holders in building and loan associations, whose assets last year amounted to $450,000,000; the members of insurance companies, which have in force nearly 2,000,000 policies, amounting to $5,000,000,000. If the wealth of all our millionaires were welded into one piece and placed alongside the wealth of the common people in such institutions as have been named, it would not be relatively as large as an acorn alongside a watermelon. Therefore the millionaires are of all others the debtor class to whom a panic can do the least harm. Even if it has depreciated, for the time being, the value of their stocks and bonds, they can simply turn the key in their safe deposit vaults and wait for better times to restore values.

Mr. Bryan admits freely that the savings bank depositor, the man who has invested his money in the solid securities of the country, will have his money reduced in value under the free coinage act by its lessened purchasing capacity, and so he says: "Buy property, buy commodities." In other words, "things are going to go up in value; speculate for the rise, and be happy." When we call to mind the people to whom this advice is addressed, and its probable result, it is difficult to believe that we are listening to a presidential candidate in the United States in the last decade of the nineteenth century. Can such a speaker be a responsible person? Just reflect for a moment as to the class of our depositors. As stated, there are $2,000,000,000 in the savings banks of this country, held by 5,000,000 people. Altogether there are probably 12,000,000 of our citizens who are directly interested in these savings. The amounts on deposit average $400 to each depositor. Now, what property or what commodities can the widow, the orphan, the domestic servant, the wage-earner, the salaried clerk whose time is fully occupied in his business, buy with $400? Can they buy real estate with it? Is any one of them fitted to go into the market and buy commodities, and to pit his ignorance against the experience of men in the business? Why, if Mr. Bryan's advice were to be taken seriously, we should see the savings of years gobbled up by land sharks of every description.

Our savings banks have always, and justly, been regarded as the perfection of safety and prudent management. They are hedged around with precautions which safeguard the deposits in every conceivable way. Even during the throes of the civil war, when values generally were so disturbed, confidence in the savings banks was not only unshaken, but grew steadily, so that at the close of the war it was found that savings bank deposits had increased seventy-five per cent.

In his violent attack upon trusts Mr. Bryan allows the silver trust, the greatest and most iniquitous of them all, to pass unnoticed. This is very regrettable. What are the silver interests in the west? Even now, with silver in disgrace, as it were, the output of these mines averages $75,000,000 per annum at coining rates, while in their palmy days they have paid as much as $175,000,000 in dividends in the space of three or four years. Behind the mint interest stand the colossal estates of such multi-millionaires as Hearst, Flood, Mackay, and a score of others, whose wealth aggregates about $550,000,000. The silver mining men had influence enough to induce, nay, to compel, our government to purchase silver of the value of $500,000,000 to add to our currency under the Bland-Allison and Sherman acts. By these purchases the country has already lost, at current rates of silver, $150,000,000. But their appetite has grown by what it fed upon, and, their demand upon the government having risen from a purchase of $2,000,000 per month under the Bland-Allison act to $4,500,000 under the Sherman act, they now, like the camel in its master's tent, throw decency overboard altogether and demand the whole thing. In other words, they insist upon the free coinage of silver at sixteen to one, unlimited and independent.

But how have they so worked upon the feelings of the people that they have enlisted so many of the farmers and the wage-earners on their side to fight under their piratical banners? Well, for the past two or three years the silver men and their representatives have been engaged in a great missionary work among the farmers. These latter number five million. Allowing the usual American average of five persons to each family, and add two more individuals for hired labor, and we have a total of thirty-five million people directly interested in farming,—that is, one-half of the entire population. If we add the population of those villages and towns adjacent to the farms and depending upon them to a great extent, it will be seen that there are probably forty-five million people in this country who are bound up in agriculture. As all wealth springs from the soil, so the farmer is a great manufacturer of wealth, or property, or capital, which you will; he is also, *per contra*, a great consumer. If he does well, the village store does well, the wholesale house in the city does well, the manufacturer does well, and the wage-earner does well; so that in reality the farmer is the key to the whole situation. Hence the great amount of trouble, care, and expense which the silver men have taken with the farmer. Expense? Yes; probably $10,000,000 would not cover the amount. But we don't know. There is no doubt, however, that London and Paris, where all the profit of our silver mines goes, would contribute handsomely to prolong the life of the silver goose which lays such beautiful golden eggs. Has it entered the head of any one that the vast amounts of money extracted from the bowels of the earth in Nevada, Colorado, Wisconsin, Utah, and New Mexico are expended on these arid countries? Do they look like it? No. All that money is carried to London and Paris and spent there. England has no absentee landlordism to compare with this.

The first thing the silver men did was to detach the farmer from his allegiance to sound money by endeavoring to persuade him that he had been very badly treated by the act of 1873, which, for the purpose of their argument, they choose to call the "crime of 1873." In passing, it may be stated that the so called "crime" was simply the codification of existing laws touching silver, and the decision to resume specie payments on a gold basis in 1878. The "crime" consisted in bringing this country to a gold standard. This act has met with the approval of every civilized country in the world; it was under discussion for three years, reams of information were printed about it, and there was not a member from the Pacific coast who did not consent to the legislation. Senator Stewart himself was especially prominent in its indorsement. The fact is that at the time that law was passed there was no profit to be made in free coinage, since the price of silver was higher than the price of gold. It was not until many years afterwards, when the price of silver had fallen considerably, that it entered into the heads of the silver men that it would be a good thing to revise that statute in their own interest. Knowing the extraordinary alertness of the silver men, no sane person will believe that any legislation affecting their interests could take three years in passing through congress without their knowing all about it.

By the use of distorted figures in parallel columns the silver men have sought to show that the price of silver began to fall in 1873, and that promptly it proceeded to drag the price of wheat down with it. The audacity which they showed in printing figures entirely at variance with fact was a source of great gain to them, until the writer exploded their theory by showing that reference to the files of the Chicago stock market proved that the fall in the price of wheat, instead of beginning in 1873, when silver began to drop, did not begin until 1883, and further proved that at no time was there any sympathetic action between the price of wheat and silver. The silver men talked so loudly about the farmer's losses since 1873 and the ruin brought upon him, as they claim, that their mere insistence gained many converts. To every one it is apparent that the price of wheat at the great central markets had fallen off much. This was inevitable from the fact that between 1875 and 1891 the wheat area under cultivation in this country had increased over forty per cent, while India, Russia, and the Argentine Republic, with their cheaper labor, fertile lands, and splendid climate, were flooding our European markets with cheap grain. The silver men have closed their eyes to that argument, and reiterated that it was the "crime of 1873" that caused the price of wheat to go down.

United States senate document No. 316, of the present congress, gives the statistics since 1862 of the four great States of Iowa, Kansas, Minnesota, and Nebraska. This table shows that from 1862 to 1890 the average price of wheat *on the farm* was 71.05 cents per bushel, as compared to 71.4 cents per bushel in 1862-66. That is to say, for nearly twenty years a uniform price was maintained. During this time the farmer's position was greatly improved by the discovery of cheaper methods of cultivation and a considerable fall in the price of all articles purchased for his own consumption.

It is perhaps a thankless task to prove to any man that he is not so badly off as he fancies himself to be, but that he is in reality better off. Such, however, was the case up to 1890. For a great prosperity overtook the country, as a result of the act of 1873, and continued from the resumption of specie payments in 1878 until 1890. In that year, however, the Sherman act began to inject its enormous flood of silver into our circulation, thereby weakening the whole character of our money, and creating distress at home and abroad, which closed our factories, threw our wage-earners out of employment, and hurt the farmer So the farmer's loss was caused, not by the so-called "crime of 1873," but by the iniquity of 1890.

Now the question arises: What will the people of this country, and among them the farmer, gain by free coinage, and what will be the course of events following upon its introduction? Under free coinage it is proposed to coin free of charge all the silver which can be offered at the mint,—that is, presumably, to the working extent of the various mints, which is $50,000,000 per annum. There has been no talk up to the present time of issuing certificates against these deposits for coinage; so it behooves us to stick to our text. Here, then, we have a gain $50,000,000 per annum. But, inasmuch as there can be no doubt that all the gold in this country will take to its wings and fly away the instant free coinage becomes a certainty, we have a loss of $600,000,000 gold from our currency, as a set-off to this yearly gain of $50,000,000. In other words, it would take twelve years for us to bring our circulation up to its present figure of $1,700,000,000.

Such a contraction of our currency would instantly bring on a panic which would convulse the country, stop all our manufactures, and fill our streets with starving workingmen out of employment. This would, of course, instantly react upon the farmer. None of the silver men dispute the certainty of a panic on the introduction of free coinage; but all content themselves with the belief that it will be short-lived, and then, say they, we shall move on to better times. What a delusion! Because this country steps down to the level of Mexico, China, India, and the republics of South America, does that mean prosperity? Has it meant it in those countries? A cheap 53-cent dollar would mean, as it always has meant, a cheap country and a cheap wage-earner. Meantime, during the business stagnation, which would undoubtedly last for years, the world's trade would go past us, and who would be bold enough to say that we should ever regain it? It has not happened once in the whole history of the world that commerce has returned to a country which it once left.

Certainly no enemy would have dared to attempt the injury to this country which the silver men have assiduously tried to commit during the past few years. Would the wage-earner be better off under free silver? Impossible. Supplies would cost him nearly twice as much as now, while his wages would remain as they are, if, indeed, he should not be thrown out of work by the panic which must inevitably follow free coinage. The farmer and wage-earner will very properly ask at this juncture what is he to do, if he is not to vote for free coinage of silver. Times are admittedly bad with him now, and have been since 1890. What can he do to improve them? The answer to this is that both have been very much deluded in the belief that free coinage would mean to them more money; they have listened to proposed remedies which the experience of the entire world has proved to be a delusion and a snare. This country does not want more money. It could do an enormous business to-day on half the money capital which it has at the present time. The trouble is that the continued agitation of the silver men and the uncertainty as to the outcome of their efforts have bred distress on every side, and the money that we have has lost its fluidity or mobility; it does not circulate.

If it were possible that the whole world should understand to-morrow that this country through all its parts was well content with its present circulation, and that all agitation would at once cease, and would not be resumed during the next ten years, so great would be the influence of the confidence felt that within two or three weeks business would be all that every one could desire, and the profits of the farmer and the wage-earner as assured as either of them could wish them to be. Just as the French Revolution could be explained in one word, hunger, so the badness of our present trade can be explained in one word, distrust. It is not the banker who has locked up money, as the silver men mischievously state. Locked-up money brings no profit to any one. It is the lack of confidence, the lack of certainty as to the future, which destroys the courage of our business men and reduces the commerce of the country to its present low ebb.

GAS VERSUS ELECTRICITY DIRECT FROM COAL.

By D. M. Dunning.

FOR a number of years we have heard of the great things that were to happen when science achieved the production of "electricity direct from coal"; yet it does not seem to have occurred to many that ordinary illuminating gas is, and always has been, produced "direct from coal." The purpose of this paper will be to show in a practical way that, with the modern gas works, handled in an up-to-date manner, an efficiency can be attained which is about all that could be produced, even should science succeed in the production of "electricity direct from coal." In doing this it will be desirable first to briefly describe the modern gas works and some of the essential advantages to be derived from it, in comparison with the works in use until the past few years.

The day has certainly gone by when the gas manager can sit quietly around and allow his works and business to run him. He must now reverse things,—run the works and push the business; and so thoroughly has this become recognized that the industry, where properly managed, has already become one of the most prosperous in the land. It has held its own through the shrinkage of values and financial reverses of the past few years better than almost any other, and, where it has kept clear from electrical entanglements, has paid its dividends with surprising regularity.

In the way of the utilization of residuals, and illumination through incandescent lamps, it has, through the aid of science, made most rapid advances, and still presents, in these and other lines, the broadest fields for scientific research and investigation. At various times it has, in the minds of many, been threatened with serious, if not fatal, competition from electricity; yet the gas industry is probably to-day in a healthier and more prosperous condition than it would have been if electricity had never been a competitor, because the electric light has created a demand for more light and a stronger light, which, together with its competition, has stimulated the gas industry to improvement, and to advance and extend its business; and on these lines, and with the aid of lower prices, the future manager seems to have an almost unlimited field.

In the evolution of the modern gas works one of the first and most important steps was the construction of the "regenerative furnace."

Only a few years ago, with the old-style furnace then in use, it was the common thing to consume fully one-half the coke produced, in the furnace itself; and, with no special effort made to find a market for the other half, it often became a cumbrous thing about the works, and was disposed of in liberal measure and at nominal prices, which practically destroyed its market value. We now have in common use the "regenerative furnace," which, with its essential features of primary and secondary combustion, is a remarkably economical generator of heat. By secondary combustion I mean the combustion of the unconsumed products of the first combustion, which is brought about by a secondary supply of air at a point just above the furnace proper. In this manner, together with an ingenious arrangement of flues for heating the air-supply with the otherwise waste heat of the furnace, the efficiency of the furnace has become fully doubled, so that we are now able to carbonize our coal with about one-fourth of the coke produced. Another important advantage of the modern furnace is the transfer of the coke without quenching, whereas, with the old furnace, it was necessary to quench the coke, and then fire it up again. This furnace also affords a very marked saving in depreciation and labor, especially if run with moderate heat, as it should be; and the large amount of coke saved, if properly stored and marketed among people educated to its use, becomes a very important by-product, and, in such works as are in proximity to the bituminous coal fields, nearly, if not entirely, liquidates the coal bill.

And, with the great saving in this by-product, there has been achieved a still greater in the two other by-products,—namely, tar and ammonia. Within the memory of the writer, coal-tar was a serious annoyance to the gas manager, because it had to be disposed of in some way other than as ordinary sewage: and it was not an uncommon occurrence to be obliged to haul the major portion of it out into the country and there burn it, hoping to sell the remainder for local use for enough to defray such expense. To-day it can probably be safely said that in no branch of chemistry has science delved so deeply as in that which deals with the black and sticky mass of coal-tar, and certainly from none has it produced more brilliant results, the productions being already numbered among the thousands, comprising nearly all of our most beautiful colors, such as the aniline series, and the most important of our medical remedies, one of which—phenacetine, of the anti-febrin class—has acquired a world-wide reputation; altogether, the list seems as limitless as the starry heavens, and as yet about as unexplored. Saccharin, a thousand times sweeter than sugar, suggests that, if we have sufficient faith, and work, we may yet live on tar. Coal-tar products have acquired so important a place in the arts, sciences, and manufactures that this by-product has become a well-established article of commerce, and undoubtedly pays, for the average gas works, about twenty-five per cent. of the coal bill.

Not until a recent period did gas companies—in this country at least—make much of an effort to save their third important by-product, ammonia ; and it is an interesting feature of this saving that the necessary treatment of the gas in process of manufacture, in connection with such saving, has been so material an improvement over the old treatment as to more than compensate for any added expense caused thereby, leaving the ammonia saved out of the question. Formerly the gas was often washed in a shower-bath of cold water, and many of its illuminants were washed away with the ammonia into the sewer. Now only an exceedingly small quantity of water (which has great affinity for ammonia) is allowed to come in contact with the gas, and this contact, by ingenious mechanical contrivances, is continued over a long and sinuous course, entirely removing the ammonia without disturbing the illuminants, and producing a valuable article of commerce. The storage and concentration of ammoniacal liquor requires careful and skilful handling, as it is an extremely fugitive substance, always anxious to escape to the clouds, and return thence to the farmer in his fields. Five to seven pounds per ton of coal is a fair production of this by-product, and betweeen thirty and fifty cents per ton of coal the average revenue.

This summary of the state of the gas industry at the present time, in respect to the saving of residuals, brief as it is, warrants the statement that the dividends of to-day are declared from the wastes of yesterday ; and the knowledge of it seems to touch, in the mind of the gas engineer, whenever by chance he happens to gaze at the chimney of an electric-lighting company, a sort of sympathetic chord in harmony with the feelings of the stockholders thereof, in the shape of a vision of dividends vanishing in smoke, worse than wasted, because an intolerable nuisance.

Important as the mechanical evolution of the industry has been, it fairly sinks into insignificance in comparison with what has been accomplished and with the possibilities in view, in the evolution of the business end of the industry, following the line of enlarged output at lower prices. And, in mentioning lower prices, it is well to suggest how very much depends on a proper representation of the industry to the people, as it is not so much what the people pay as what they think they pay that counts, and "what they think they pay" depends almost entirely on their feeling that they are getting the worth of their money. In the development of the business end of the industry we have a field of almost limitless extent, and to properly go over it would require a paper by itself. Such a paper would consider the policy of offering to the customers of the company small cooking and heating utensils on condition that the connections and fittings therefor be purchased at a nominal price, and of following soon with a second offer, to exchange these utensils for larger ones, which would generally result in the retention of both by the customer. Then comes the well-stocked store of gas appliances centrally and conveniently located, and the exhibitions given therein, including cooking by experienced cooks furnished by the company and using the modern gas range, such exhibitions to be in charge of the lady managers of the various charitable institutions of the city with the privilege to them of disposing of the food products for the benefit of their various charities. All this to be followed by a vigorous effort to supply all classes of customers with cooking and heating appliances of all kinds and sizes. And then follows the canvassing for customers, for which a commission is paid, together with the piping of houses and the sale of fixtures, thereby enabling the poor man to become a customer at an outlay of from five to ten dollars, and giving him, with the Welsbach lamp, a better, more economical, and more satisfactory light in every way than he had with oil.* And this only opens the door for an almost unlimited number of other developments, the introduction of gas engines being a very important one. For lack of space we must dispose of this portion of our subject with the remark that the valuable management for the gas works of the future will be the management that understands how to extend the business and has the ability to do it ; and it will be a mission requiring lots of energy, patience, and hard work, but fully as beneficial to mankind as any in the land.

Progress seems to be the watchword in all lines of industry in the present age, and our electrical friends just at present are unusually active. Among the many startling announcements of recent date in reference to progress in electric lighting probably none seems so tangible, and has attracted so widespread attention in the scientific press, as the discovery of Dr. W. W. Jacques of Newton, Mass., of a chemical process by which electricity can be generated direct from coal.

A fair representation of these articles comes to us through the July

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* At Auburn, N. Y. (population, 30,000), over three hundred customers have been secured in this way during the past two years. Many of these had their houses already piped, but nearly one hundred houses have been piped by the company, which has received during that time: for the piping of houses, $1986.52 ; for ordinary gas fixtures, $2,023.80 ; for Welsbach fixtures, $3,220 ; for stoves, ranges, and other cooking and heating appliances, $2,023.80. Stoves, ranges, etc , had been largely supplied previous to this time. About 30,000 feet of wrought-iron pipe of various sizes have been used during the past two years, about one third of which was for services.

number of THE ENGINEERING MAGAZINE, and the first thought of the practical man is as to how it will affect existing interests and investments. When such high authorities as Professor Cross of the Massachusetts Institute of Technology and Professor Rowland of Johns Hopkins declare it to be one of the great inventions of the nineteenth century, it certainly behooves one to give it a careful investigation.

So radical are the changes in the production of electricity by this method that one writer, on page 657 in this July number, is sanguine enough to proclaim that "dynamos will be sent to the attics, and it will be cheaper to heat and work by electricity than by fires." And similarly we find in other magazines page after page of interesting scientific enthusiasm pertaining to this particular invention, until we are constrained to give it a careful and impartial examination. The process may be briefly described as follows.

Iron retorts are set up on end in a furnace. The retorts are partially filled with caustic soda. They also contain a piece of carbon suspended from the top, and are provided with an air-supply at the bottom. The furnace and contents are to be brought up to a temperature of 400 or 500° Centigrade, and a supply of air forced up through the fused mass of soda, the oxygen from which attacks the carbon and forms electrical energy, with which arc and incandescent lights can be immediately maintained. The efficiency is said to be such that thirty 16-candle incandescent lights were maintained for nearly nineteen hours with a consumption of only eight pounds of carbon in the retort; and this is pronounced an efficiency of about ninety per cent., for the eight pounds of carbon consumed in the retort. But what about the perhaps eighty pounds of carbon consumed outside of the retort to maintain this temperature of 800 to 900 degrees Fahrenheit and the air-blast for the nineteen hours? So disposed are enthusiasts in science to exalt any new thing that this, probably the real source of the energy, is passed over in comparative silence. If we call an enthusiast's attention to this, we are told that they are on the track, and the next step will be to accomplish all of this without the aid of outside heat; which brings up the suggestion: suppose you could do this without the aid of outside heat, or, what is more probable, suppose a small portion of the energy generated—say not to exceed ten per cent. of it—could be diverted to maintain this heat and pump the air. "Then," the enthusiast exclaims, "we would move the earth; we would certainly revolutionize all existing things." "But what about the carbon consumed in the retort?" suggests the practical man. Could you not manage in some way to furnish this, or a large portion of it, without cost? And, if you could, suppose we compare the efficiency which you would then attain with the efficiency of the modern gas works. They have the retorts set in the furnace. They are charged with carbon in the form of coal. According to scientific authorities, something more than twenty per cent. of the energy is driven off in the form of carburetted hydrogen, called gas, which can be safely and easily stored without loss or deterioration for any length of time; and the practical man claims that the other eighty per cent. is retained as follows: forty per cent. in the form of coke, twenty-five per cent. in the form of tar, and fifteen per cent. in the form of ammonia.

One-fourth of the coke, or ten per cent. of the entire amount of energy, suffices to do all the work of heating the furnaces, and the balance of these residuals, in many cases, sells for enough to pay for all the coal, and, on an average, should pay for about eighty per cent. of it.* But the scientist comes forward with an array of heat units and standard candles to prove that eighty per cent. of the energy does not remain in form of the above-named residuals, and the practical man waves him aside with the exclamation that they pay eighty per cent. of the coal bill, and that the energy which pays the bills is the right kind of energy for him; and he claims that, if he can eliminate eighty per cent. of the raw material by the sale of residuals, then he has a right to consider the entire production of the original article sought as the production of the remaining twenty per cent. of the raw material, which would show an efficiency of the full one hundred per cent. of energy. And then he calls attention to the wonderfully efficient character of this energy when utilized with the oxygen of the atmosphere through bunsen burners, incandescent lamps, and gas engines for heating, illuminating, and power purposes.

The gas engineer calls on nature twice during the carbonizing of his coal for assistance from the oxygen of the atmosphere, as has been shown under the description of the regenerative furnace; he calls again for assistance in the distribution of his product under the weight of the atmosphere, which does it quietly and effectively, unseen and unknown to most of us; and he calls again at the utilization of the product for a supply of oxygen to support its combustion, for all its various purposes of light, heat, and power, calling twice in the use of the Welsbach lamp, or for a double service, and producing at once the most economical and efficient artificial illumination yet known to man, and which may well be called "one of the great inventions of the nineteenth century." And thus he goes hand in hand with nature in all the ways of his profession, so differently from his friend, the electrical engineer, who seems at all points to be endeavoring to thwart

* At the gas works in charge of the writer, four hundred miles from the coal mines, the residuals sold pay more than eighty per cent. of the coal bill

her, and, with his lamp, depends for his success upon his ability to oppose her. For nature abhors a vacuum.

And now comes the philanthropist, and desires to know why, under all of these advantages, the price of the product does not fall. Why are not companies formed to give it away, so that people may rise up and call them blessed? The reply might be made that, in common with other corporations that deal with the public, they are always sure of the blessing. Perhaps a better reply would be that water is free, free as the air, and stored in inexhaustible quantities at the very doors of many of our cities; and yet it costs the people of most cities more than gas. Suppose it were possible to store daylight and distribute it by night through "vacuum tubes;" does any one imagine that it could be done for nothing? It is not the first cost of the raw material that counts in a service of this nature. It is the long train of contingent expenses that rises up to swamp the enthusiast, when he attempts to move the world too rapidly. But the world is bound to move, and we are glad of it, and we hope to see the Jacques furnace improved so that it will become self-sustaining,—perhaps float off into perpetual motion. And, when this is accomplished, then we think that, in point of efficiency, it will just about begin to get into comfortable competition with the modern gas works.

THE UNDERGROUND TOPOGRAPHY OF A CITY.

By Wm. Barclay Parsons.

THE most striking development in constructive science during the last fifteen years, and the one productive of the most far-reaching results, has been the growth of tall-building construction. Until the advent of the elevator, buildings were limited to such height as could be climbed conveniently by means of stairs, and therefore buildings above six stories are of very recent date. The old buildings had a cellar, which was regarded as a sort of necessary evil and made as shallow as possible, and foundations of a very simple character. For the latter no general study of the ground was necessary, and even the dimensions of the footing courses were regulated by general custom, or left to the discretion of the builder.

As buildings commenced to grow in height, their foundations began to grow in depth, and to assume such importance, on account of the loads they had to bear, that more attention had to be given to their design, and special investigations made in respect to the underlying material.

In Chicago, where tall-building construction may be said to have been born, it was found that the soil was not capable of supporting the new great weights, and an accurate study of the sub-surface conditions became necessary. The investigation showed that the comparatively firm surface on which ordinary building operations had been conducted was a thin crust overlying a very compressible soil, and that this top crust could sustain but a certain moderate maximum load without undue settlement.

With the deepening of the foundations, people have been led to consider the utilization of the sub-surface space, so that a modern building has in very many cases two sub-cellars, and for recently-designed buildings in the city of New York even a third has been added.

Thus the elevator, which was intended to increase the height of buildings, has been the most influential agent in increasing their depth.

The purpose of this article is not so much to show the necessity for examination and study of sub-surface conditions as to show how such examinations are made and what the facts are which are thus discovered. In the first place, the engineer who is planning important sub-surface structures must go back to the time before the site was occupied by the city, and learn what he can of the originally existing conditions.

We are all familiar with the characteristics of the surface of the open country,—with its hills and hollows, water-sheds and streams, solid ground and marshes. When the open country comes to be occupied by a city, the topography is modified and changed. Hilltops are cut away, valleys are filled up, steep ascents are reduced, swamps are converted into dry ground, and streams disappear. But these changes, and especially the latter, are more apparent than real, because the old surface of the ground, if filled on, is not made one with the new, and can be found even after a long period of time and easily recognized, if sought for. Streams and their drainage areas are the most striking features of surface topography, and with the building of cities the streams do not pass out of existence, though they may disappear from sight. Although the streets are paved and all house drainage and apparently all the surplus water are carried away by sewers, nevertheless enough rainfall finds way through leaks in the pavement, through unpaved yards, or through the public parks, to furnish a considerable volume of water, which flows underground along the lines of the old streams.

And so with the swamps; although a swamp may be filled in and converted into what is to the eye, and, in fact, to all ordinary purposes, solid ground, nevertheless it still exists as a partially compressed, but still further compressible, sub-stratum, so that, if the engineer were to treat the locality according to what it appears to be, he would soon find out his mistake.

As a first step, therefore, in sub-surface investigation, the engineer should have before him some description showing what the original surface was and wherein that surface in its topographical features differs from the surface as presented by the city.

Taking New York as a type, the accompanying map (Fig. 1) represents that portion of the city lying south of Fifty-ninth street and Central park, with the streets as now laid out, the original indentations of the shore line, the old streams and ponds, and the high ground. The changes that have been made are very great and easily seen. The river fronts have been built out to a distance, in some places, of several hundred feet. Every stream and body of internal water has been converted into dry ground, and yet these changes are but superficial, for the old shore line and river bottom are still to be found; the swamps have been compressed, but not removed; while the streams, as has been said, still continue to flow as they have done for centuries, along their old courses to the rivers, and on to the sea.

There are two methods of ascertaining the composition and struc-

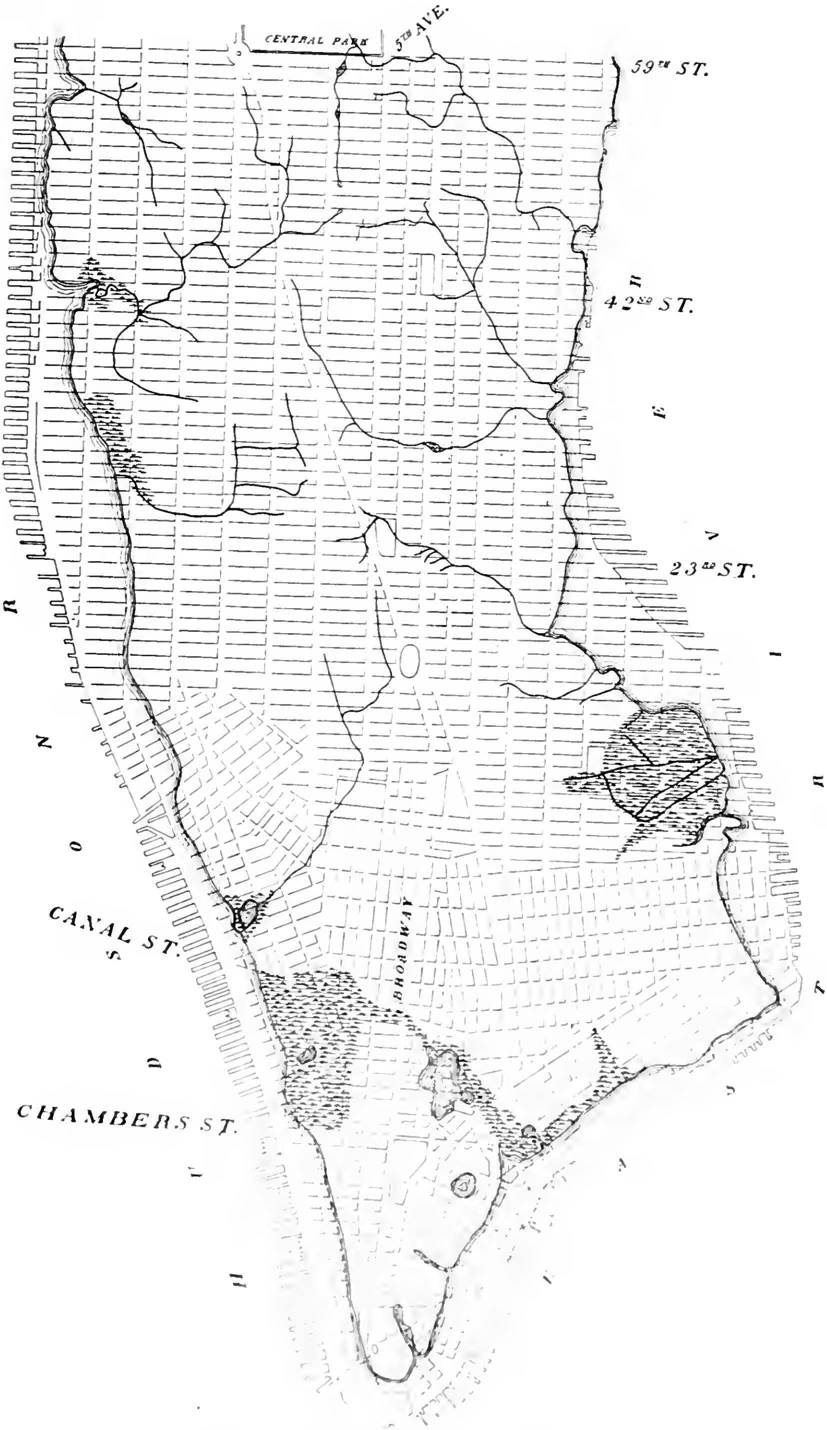


FIG. 1. MAP OF PART OF NEW YORK CITY.
Showing old topographical features and modern changes

ture of the underlying material,—some sort of driven-well arrangement applicable to soft ground, or the diamond drill for rock. The simplest style of the former, and the one generally used for such work, is known as the "washpipe." This consists of a wrought-iron pipe about two inches in diameter, the first length of which is driven a few feet into the soil by hand, after which a smaller pipe about ¾ inch in diameter is inserted. This small pipe has its end drawn down to a flat or round nozzle, a pressure pump is connected with the upper end, and then water is forced down, which, rushing out of the nozzle into the ground, stirs up the particles of sand and carries them with the ascending current up and over the top of the two-inch casing. The casing then settles by its own weight, or else is forced further down by blows of a small portable machine, like a pile-driver. In this manner the tubing can be driven to a considerable depth, additional lengths being connected by ordinary sleeve-couplings. The material, as it is raised, can be caught and the water drawn off: and from the samples of the underlying soil thus secured the exact composition of the ground and any variation in it can be determined and recorded. By sinking holes at close intervals a very complete story of the sub-surface material can be obtained. If the pipe reaches rock or other hard substance, it can be driven no further, and, if it is necessary to determine accurately what that hard substance is,—whether a boulder, a thin layer of rock, or rock in ledge,—recourse must be had to the diamond drill. This instrument is a large boring machine, the drill of which is a hollow steel tube with an internal diameter of about one and a half inches, its edge set with pieces of cheap diamond, which wear away the surface of the rock and cut out a round core that can be raised to the surface. This core will show the structure of the rock, its composition and strength, and the presence of flaws.

The level of the ground water can be measured by dropping a line down through the two-inch test pipe, before it is withdrawn. In locations near tide or other bodies of permanent water, and in a porous soil, the level of ground water is approximately that of the main body, but it will rise above it according to the non-porosity of the soil. In this matter, which has a very strong bearing upon any engineering construction, the engineer has to be on his guard against pockets of water, or water held back in the soil by a sub-stratum of clay or other non-porous soil, which, if unexpectedly tapped, is apt to burst forth and do considerable damage.

In the construction of high buildings there is required a knowledge of sub-surface topography; it must be known whether the ground is made or natural, whether flowing water is present, what the level of ground water is, and of what the underlying material is composed. But such investigations, important and necessary as they are to the locality, are usually too far separated to give a sufficiently connected series of studies, by which all the variations and conditions can be noted and the sub-surface topography portrayed as a whole. Such a study can be made only through test holes set close together and covering an extended area, and such investigations are apt to be made only along a line of streets in connection with some municipal or railway work.

An investigation of this character was undertaken in New York by the rapid transit commission of 1891, when an underground railway was laid out along the line of Broadway. By means of washpipes test holes were sunk at every street intersection along the route, and the material carefully sampled. From these samples it was easy to determine the depth at which any variation in the sub-soil occurred, and so construct a profile, or rather a vertical section, a portion of which is shown in Figure 2. This illustration indicates what would be the appearance, if a cut were made the length of Broadway and one half of the street removed. It will be seen that the surface of the street is no indication whatever of the existing sub-surface conditions. Rock is further down where the surface is highest, the configurations of each stratum do not always conform to the rock or surface line, and the several kinds of sand have their hills and hollows as sharply marked and as easily distinguishable as the hills and hollows of the open country. In the profile in question, while the quality varies, the material is all sand and porous. But suppose one of the layers were clay, or that a thin seam of some such non-porous material occurred; then these strata would have an additional interest as indicating the line of flow of underground water, and the possible existence of pockets. In the porous soil in question the level of such ground water is nearly horizontal and but a short distance above high tide, which is indicated by the straight line.

There was a time when what is now the Hudson river, instead of flowing into New York bay, flowed into the Atlantic ocean some eighty miles further away, and when the rocks of the lower part of what afterwards became Manhattan island stood many hundred feet higher than the rock line shown in the section. The reader can picture to himself the great glaciers which followed, and which, after grinding away the hills, left the rock surface ploughed with the deep furrows that we find now; and then the slow deposition, by other glaciers and ice caps, of the sand strata, results of their destructive action elsewhere; and so the building of that structure, layer by layer, on which some day was to be built the very heart of the metropolis of the western continent.

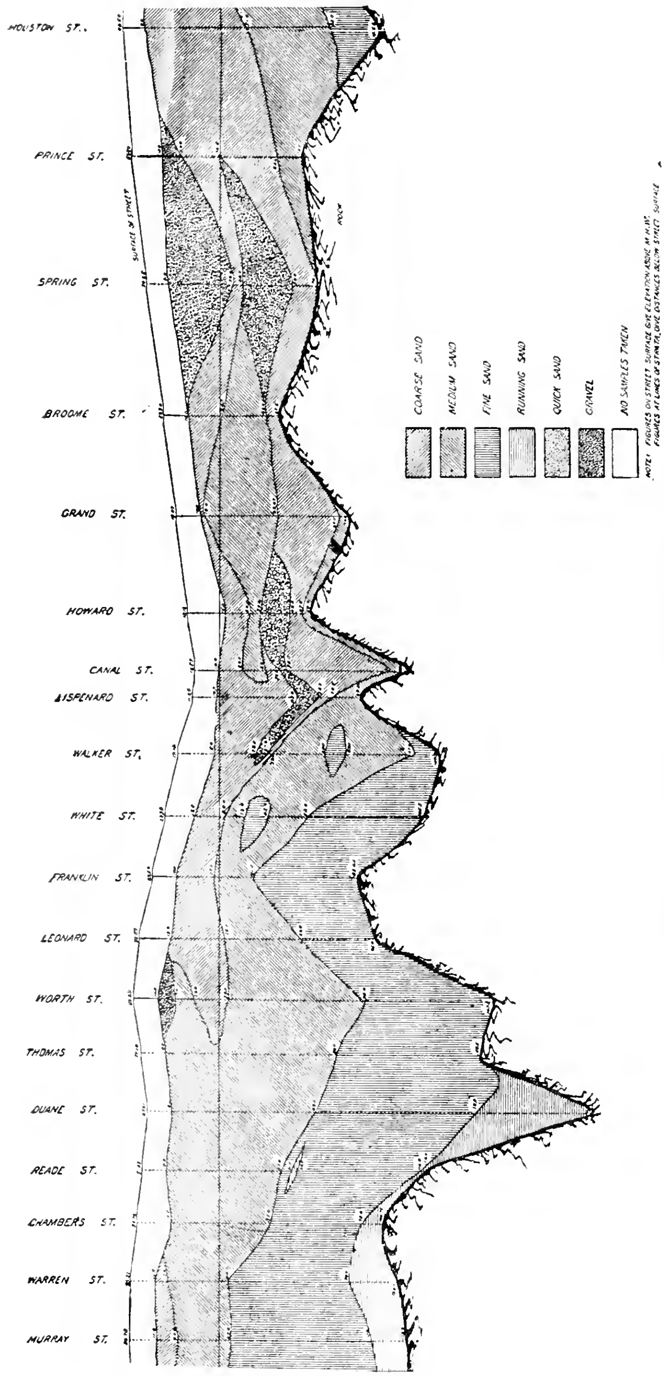


FIG. 2. SECTION ALONG PART OF BROADWAY, SHOWING UNDERLYING STRATA.

What is shown here of New York, both in the section and in the map, is but typical of other cities. The surface as existing differs from what the aborigines or even the oldest inhabitants knew,—a soil overlying the bed rock at various depths; configurations of the rock and surface not necessarily having any relation one to the other; the soil composed of layers of different materials, and these layers existing in all sorts of shapes and frequently with a sharp line of demarcation; and the streams still flowing, but with diminished volume, in their old channels, although covered perhaps by many feet of filled-in material.

In addition to the natural, the artificial features are as strongly marked, and, for practical purposes in the carrying out of construction work, equally important. Underneath the streets of large cities are laid pipes for water, gas, steam, and air, electrical subways, sewers, and other similar structures necessary in modern urban life. All of them, except the sewers, are laid without much regard for topographical questions, but the sewers must to some extent follow original

FIG. 3. PART OF NEW YORK, SHOWING OLD WATER COURSES AND MODERN DRAINAGE.

drainage areas, unless the sewage be pumped. These sewers, therefore, are, in fact, artificial brooks and streams, and, by carrying the larger part of the rainfall and all of the house-drainage, are intended to supplant the original water-courses. They start—or rise, as would be said of brooks—along the edge of the divide which separates one sewerage district from another; follow along the streets in small pipes; then form junctions with two or more, the pipe being increased to a brick sewer; and then pass on, growing in size and volume of flow, picking up other branches and feeders, just as the stream is fed by small brooks, until at last a number of sewers are gathered into one large trunk sewer, in which there is at all times a steady flow, and so on to the outfall in the sea, or other point of disposal. Now, these artificial streams with their divides, although in large measure similar to the natural streams, which they have displaced, frequently differ from them in detail of location; and so beneath our feet in any large city it can be said that there are two distinct systems of drainage,—the artificial system made by man, following straight lines and to some extent regardless of the surface or subsurface topography, and the system laid out by nature, which, though largely supplanted by that made by man and buried out of sight by him, still struggles to maintain its original independence. Figure 3 is a map of a small portion of the city of New York, showing the position and direction of flow of the sewers and the approximate location of the old water-courses.

Were it possible to take up the surface of the street and its immediate underlying soil, or, rather, if a photograph could be taken by Röntgen rays, we could get a picture of which the illustration in Figure 4 is an example. Since that diagram was made in 1890, the horse-car railway has been converted into a cable road, and two lines of cable yokes have been added to the pot-pourri, and yet the tangle of pipes and sewers shown at the intersection of Fulton street and Broadway is typical of what may be found in any great city, and in intricacy and number of pipes is exceeded, in New York, in many locations. Now, these pipes and the other sub-surface structures are quite as important a part of underground topography as the rock and the other material that go to make up the soil. In doing work the latter can be removed at will, but these pipes are to the city what arteries and veins are to the human body, and cannot be rudely or arbitrarily displaced: whatever is done to them has to be carefully planned out beforehand, the cut ends plugged, and a continuous circulation in some way secured, with a skill similar to that displayed by the surgeon.

The study of underground topography has an interesting aspect, when considered in connection with a city like New York. How

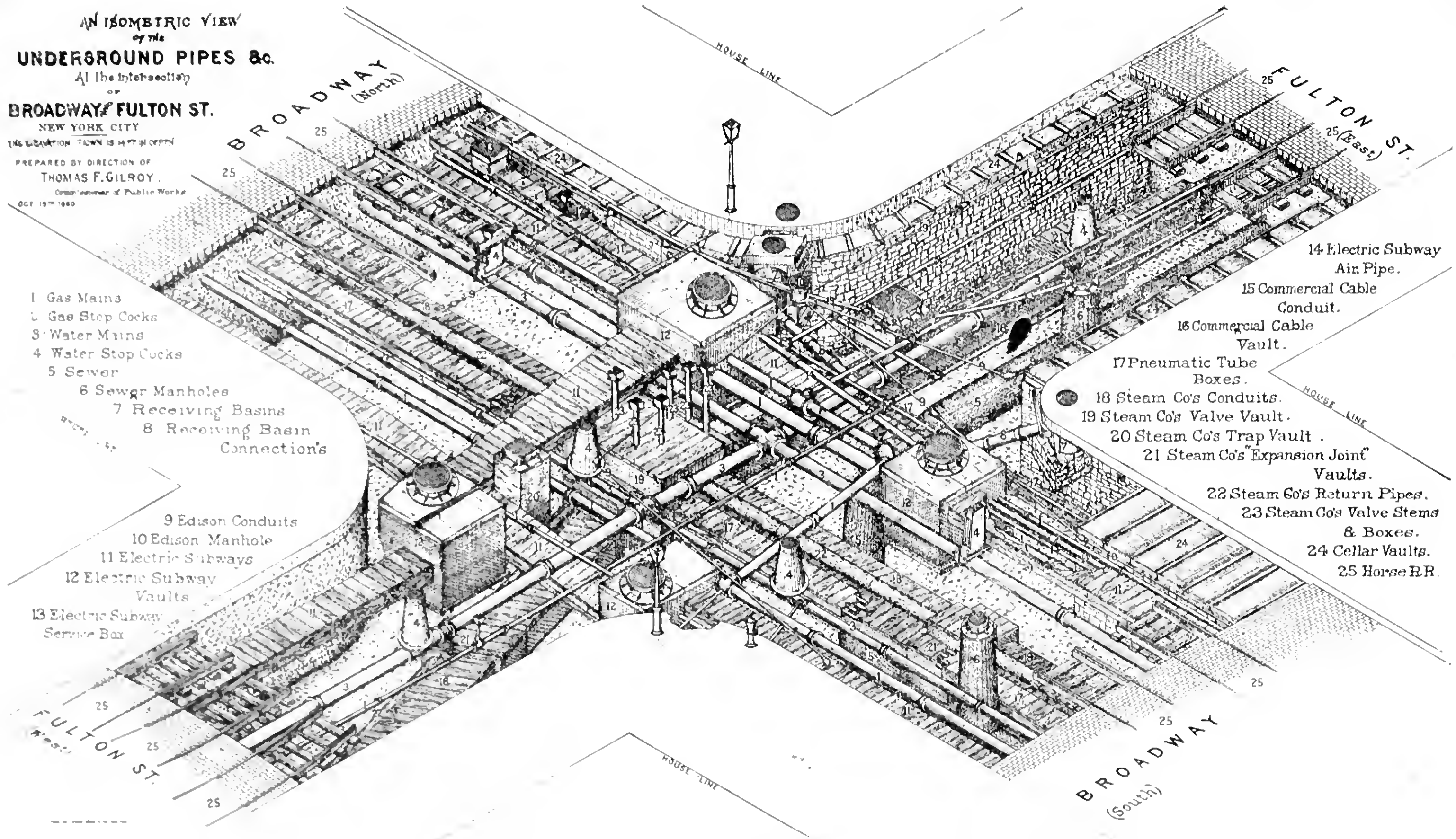


FIG. 4. WHAT IS UNDER THE SURFACE AT BROADWAY AND FULTON STREET, NEW YORK.

much more interesting is it when taken in connection with one of the cities of the old world! In the construction of the underground railways of London, a very complete view was had of the underground topography, which is described as follows by Sir Benjamin Baker, the engineer.

"When a tract of country is closely covered by buildings of varying heights, and the natural water-courses are converted into covered sewers, it is difficult to form a general idea of the physical features. In the case of the metropolis, however, a sufficient record exists of the previous condition of the country, where the excavations have, in many instances, offered an interesting confirmation of traditions.

"It is believed by competent authorities that, long before the Roman Invasion, some Celtic chieftain settled in the 'City' and called his place of business 'Lynn-din,' the Fort of the Lake. However this may be, it is certain that in early historical times the little hill on which the City stands was fronted by a wide stretch of tidal marsh land, extending to the base of the Surrey hills, and was flanked on the east by the Wall brook and on the west by the Fleet river. Between the City and Westminster, the river overflowed its northern bank to only a limited extent, but westward of that it extended inland for at least a mile, forming the swamps of St. James's Park, Pimlico, Fulham, and other low-lying districts now traversed by London railways. To the north extended the rising ground culminating in the heights of Hampstead and Highgate and the lesser heights of Campden Hill, Notting Hill, Maida Hill, Primrose Hill, Haverstock Hill, and Pentonville Hill. Between the different spurs of the northern range of hills are drainage depressions, formerly clear-running brooks or tidal channels, but now polluted sewers, with tidal flaps for storm overflows.

"To the west of Kensington and Chelsea, rising in the high ground, but traversing chiefly the low-lying district, was the Bridge creek now known as the Counters creek sewer. Proceeding eastwards, the next stream met with was the West Bourne, rising on the western flank of Hampstead Hill and flowing southwards to the Serpentine, and thence into the Thames, near Chelsea bridge. This is now called the Ranelagh sewer. Next in order was the Ty-Bourne, which flowed from Hampstead through Regent's park and thence, by Marylebone lane (whose strange windings are due to the houses having originally been built on the banks of the stream) and by the Green park, to the river between Vauxhall and Chelsea bridges. No stream of importance existed between the Tybourne and the Fleet.

"The historical stream, known for the first part of its course as Hole-Bourne and for the latter portion as the Fleet, flowed from the

Hampstead and Highgate ponds due south, passed King's Cross and along a deep tidal inlet into the Thames at Blackfriars bridge. The sudden dip in the roadways at Holborn Valley and at Ludgate Hill remains as evidence of the former existence of this useful tidal navigable channel. Though a benefit in olden times, it is hardly necessary to say that the Fleet river, converted into a huge sewer, constituted a serious difficulty in the construction of the underground railway. As regards the character of ground cut through, a considerable depth of made ground would necessarily be looked for at the east end as the line as carried through a City founded perhaps two thousand years ago and ravaged and burned by the Celts, Romans, Saxons, Danes, and Normans. In places as much as twenty-four feet of ruins and dust were cut through. At the mouth of the Fleet the chalk rubble foundation of an old fort was exposed, and at the Mansion House a masonry subway was discovered intact. Similarly, at Westminster made ground was found to a depth of eighteen feet. Remembering that between the City and Westminster the line was carried along the old bed of the river, mud and silt would naturally constitute the chief part of the excavation. The cuttings of the railway show that, if what Sir Charles Lyell called the great ochreous gravel deposit of the Pleistocene epoch were swept away, the hills and valleys of the metropolitan area would be practically unaltered in appearance. At what period in the remote past the sand, gravel, and brick earth cut through by the railway were deposited, no one can tell. It is believed, however, that England was then united to the continent: that the present site of the North sea was dry land, and the Thames a tributary of the Rhine. It is proved by the remains of animals swept down by floods and buried in the gravel at Windsor, Kew, and London, that roaming about the valley of the Thames must have been the mammoth woolly rhinoceros, hippopotamus, straight-tusk elephant, lion, elk, bison, horse, bear, wolf, reindeer, and other animals. Was man existent at this epoch? It is very generally believed that he was."

If nothing else has shown it, then certainly this extract will show that apparently so simple a thing as digging a hole can have its poetic side, and that the very ground underneath our feet has a story to tell, and an interesting one too, if we would take the pains to read it.

Space has three dimensions, but, as far as cities are concerned, it also has three divisions,—the surface, above the surface, and beneath the surface. The first is already occupied, the second is fast being penetrated by high buildings, and the third is yet to be developed to its full possibilities. It is not so long since no one thought of using the third for any purpose for which either of the other two would do, and only pipes and sewers which could not go anywhere else were placed underneath the surface and buried in trenches, generally without systematic arrangement and certainly without any means of access except the barbarous one of again tearing up the surface of the street. The space above our streets has been filled with telegraph poles with their network of wires, supports for elevated railways, and other obstructions, while the surface has been occupied by power-driven railways of some sort. Although the telegraph wires and poles have been banished to the third estate, the other obstructions remain.

At the outset it was stated that high buildings had introduced new problems, in addition to their own, and these flow from the placing of an increased population upon a limited area and the greater demand, not only for the old necessities of water and gas, but also for more of them, and for steam, electricity for all purposes, air, and, above all, for greater transit facilities. It takes time to educate the public to any radical change in habits, and therefore they are slow to make use of new resources, however advantageous.

In Europe, where greater surface congestion has obliged the people to look for relief in other directions, the sub-surface space has been utilized for the construction of railways and subways, in which pipes

TREMONT STREET, BOSTON.—AS IT IS NOW.

TREMONT STREET, BOSTON.—AS IT WOULD BE WITH AN ELEVATED ROAD.

and sewers can be systematically arranged. The work recently completed in Baltimore, that proposed in New York, and that actually in hand at Boston, indicate that soon in this country, too, the development of the space beneath the surface will be increased in a measure more adequate to the rapidly growing needs of our cities.

The greatest step in this direction is the Boston work, undertaken to relieve Tremont street of its intolerable congestion of trolley cars. The first proposition was to do so by means of an elevated railway, but better counsels prevailed, and an underground railway is now being built to accommodate the ordinary street cars.

In the illustrations on pages 1026, 1027 and 1028 are three views of Tremont street, as it is, as it might have been, and as it will be. These pictures, all taken from the same point of view, showing that busy thoroughfare restored to its proper usefulness, relieved from its present burden, and saved from a worse fate, tell far stronger than

TREMONT STREET, BOSTON.—AS IT WILL BE WITH THE SUBWAY COMPLETED.

words can of the possibilities contained in that study which leads to the fuller development and use of the space, now almost entirely wasted, underlying a great city.

THE LESS-KNOWN GOLD FIELDS OF COLORADO.

By Thomas Tonge.

THE celebrity of Cripple Creek is due as much to the phenomenal advertising it has received as to the wonderful richness of the district. Its meteor-like brightness has dazzled and practically monopolized the attention of persons at a distance, causing them to overlook the fact that there are a score of gold-producing counties in Colorado, including many new districts of undoubted merit, fully recognized by practical mining men, though little heard of by people at a distance.

If those who read this article have access to a recent map of Colorado, it will be noticed that the older and thoroughly-established mining-districts constitute a well-defined, broad belt through the State, practically following the mountains from Boulder county in the north to La Plata county in the south-south-west. This broad general belt contains the celebrated mining districts of Boulder, Gilpin, Clear Creek, Park, Lake, Pitkin, Chaffee, Gunnison, Hinsdale, Ouray, San Juan, San Miguel, Dolores, and La Plata counties, there being considerable intervals between the well-recognized mining districts.

The depression in silver mining several years ago closed many mines in Colorado, and threw thousands of miners, ore-haulers, and others out of employment. The increased demand for gold, and the unexpected discovery and development of Cripple Creek, caused such unemployed men and many others to prospect for gold. The result has been to demonstrate that the gold-bearing belt of Colorado is not only longer and wider than was supposed, but also more continuous,—that is, in the intervals between the well-recognized mining districts gold-bearing formations have also been found.

As an illustration, a brief account of two visits recently paid by the writer to one of these new districts—*viz.*, the gold belt of Gunnison county—may be interesting. Gunnison City (7,680 feet altitude), the most convenient point from which the southern end of the new belt can be reached, is 290 miles from Denver *via* the Denver & Rio Grande Railroad, crossing Marshall Pass (10,852 feet), and 200 miles *via* the Denver, Leadville & Gunnison Railroad, crossing Alpine Pass (11,596 feet).

The first visiting party consisted of a well-known geologist, an assayer and mineralogist, a practical mining man, and the writer and


GUNNISON CITY, COLORADO.

his wife. Utilizing light spring wagons, we occupied eight days in thoroughly investigating the geology and mineralogy of a tract of country about 25 miles long by about 15 miles wide, having an average altitude of that of the Hospice of St. Bernard, Switzerland, the highest inhabited point in Europe.—*viz.*, 8,200 feet,—this tract of country, with an area of over 500 square miles, having as yet a population of only about 500 persons, mostly in small "camps" of log cabins.

The country consists of a series of bare rolling hills, much resem-


THE EXPEDITION.

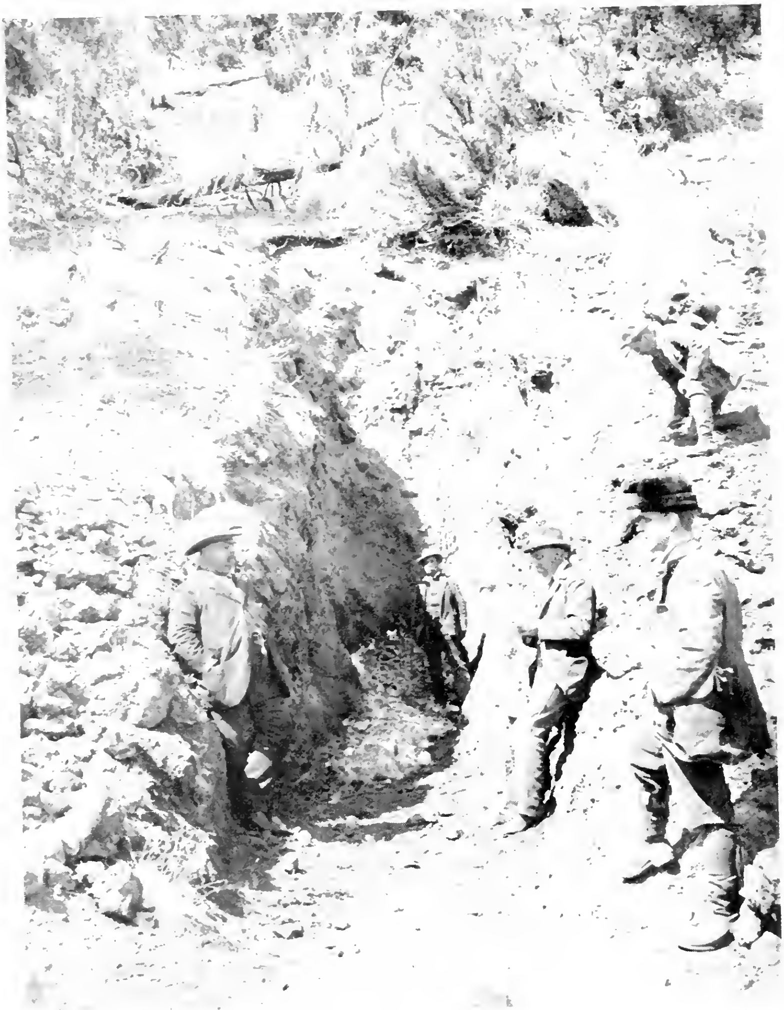
bling Cripple Creek, with occasional scattering pines on the summits, the dividing gulches having a fringe of willows along the damp bottoms. The climate is much milder than that of the same altitude in Switzerland, as this new gold belt has been for years a good grazing country, where cattle and horses forage for themselves all winter.

The region is composed of schists underlaid by granite, both being traversed by dykes of eruptive rock. The schists are traversed by a network of quartz and feldspar veins, many of which are but local. Others are fissure veins of all sizes, from a few inches to ten to fifty feet wide, traversing the region for miles in a generally east and west direction. Their value, so far as at present prospected, is low grade.

THE CEBOLLA VALLEY; ALTITUDE 8,200 FEET.

Besides quartz veins in schist, feldspathic dykes, and eruptive granites, there are true eruptive volcanic dykes and volcanic overflows. In some respects the district geologically resembles Cripple Creek.

The trip was a most enjoyable and interesting one, including a visit to the romantically-located Cebolia Hot Springs (altitude, 8,200 feet), and an inspection of the wonderful mountains of iron and manganese at Cebolla, 800 and 1,000 feet above the level, their base covering 800 acres. From base to apex there are cuts, tunnels, and shafts in solid ore. Some of these are more than 40 feet in solid mineral, and in no place has the bottom or limit of the ore been reached. About one third the area is manganese, 25 per cent. pure.



OPEN CUT IN SOLID IRON ORE.

the remaining two-thirds being hematite, averaging 55 per cent. metallic iron.

As a known gold-mining possibility the district is less than three years old, the inhabitants being mostly from silver-mining districts, possessing as capital only experience and muscle, and therefore unable to develop their claims beyond the windlass stage. For lack of capital, there are as yet less than a dozen developed properties in the entire district, the very deepest being only 200 feet.

A TYPICAL MINING CAMP.

Two of these may be mentioned, as examples illustrating the situation. In one case two prospectors last summer found and followed an outcropping, sunk, found a vein of gold-bearing quartz, pushed work, exhausted their means, got financially embarrassed, and were unable to proceed. A successful and experienced Colorado mining man with capital came along, made careful investigation, acquired the property, —a group of eight full claims,—formed a private company, erected a hoisting plant, sunk a new shaft 190 feet deep, ran 1,500 feet of drifts on a vein of white, gold-bearing, free-milling quartz of an aver-

THE BEGINNING OF A MINE

"MERELY AWAITING CAPITAL."

age width of five feet, and erected a 20-stamp mill and a pumping plant, the total capital invested being $75,000. The results are: over 70 men at work: 70,000 tons of ore already in sight, which can be mined and milled at a cost not to exceed $3 per ton, leaving an average net minimum profit of $10 per ton, or $700,000 net, now in sight for an outlay of $75,000, to say nothing of the further extensions of the vein not yet opened. Within a radius of several miles of this property there are dozens of claims belonging to impecunious prospectors, where the surface indications are as good as, if not better than, were those of the group in question when the present owners took hold, the inference being that a similarly judicious expenditure of capital would produce similarly satisfactory results.

The second case is a group of sixteen claims comprising a dyke of free-milling, mineralized granite 300 feet wide and already traced 1,800 feet long, said to carry from $4 to $20 of gold per ton. The principal owners are two gentlemen in Wall street and an American banker in Paris. There are numerous shafts, open cuts, etc., on the top of the hill, exposing the ore matter, but it is proposed to tunnel in 1,000 feet several hundred feet down the slope of the hill, and tram the ore down grade to a point on the river, less than a mile distant, where a large stamp mill will be erected as soon as practicable, thus enabling $6-ore to be mined and treated at a profit. The apparent vast extent of the ore body would indicate that this may make one of the big mining properties of the State,—something like the great low-grade Treadwell mine in Alaska.

The other partially-developed properties of the district represent capital from Aspen, Colorado Springs, Cripple Creek, San Juan, and other places in Colorado, and also from Iowa, Missouri, etc. In the wide intervals between such properties, the country is more or less dotted over with promising prospects, as yet in the hands of impecunious locators unable to proceed further with development. The geologist of the party, in his official report, says he knows of no young district which offers a better field for intelligent investigation and judicious development.

Our visit to the northern and older end of the Gunnison gold belt embraced a wagon journey of 190 miles and the personal inspection of scores of mines and less-developed properties.

The triangle of country, two sides of which are bounded by Ohio Creek and Quartz Creek, and all parts of which are within a few miles of the town of Pitkin (altitude, 9,200 feet) on the line of the Denver, Leadville & Gunnison Railroad, is very well worth the personal investigation of capitalists. The geological conditions are all that can be desired for a gold district, consisting of granite, schists, etc., traversed by dykes of porphyry, and other igneous rocks and strong quartz veins. The only extensively-developed mine in the triangle is the Sacramento, in which the ore body is continuous and well mineralized, remarkably even in character. The property is developed by over 5,000 feet of tunnels and levels, the ore ranging from $20 to

"THE DAY SHIFT," MINE TWELVE MONTHS OLD.

$300 of gold per ton, the production to date being nearly $300,000.

What has been and is being done at the Sacramento can apparently be duplicated at fifty other properties in this triangle, the only question being one of capital. At the surface the ore is quartz, containing oxidized iron and free gold, and, as depth is gained, it becomes a sulphid. It is within the mark to say that about a dozen mines within a few miles of Pitkin, with judicious management and a moderate amount of capital, could at once, or in a very short time, ship gold ore and pay dividends. There are scores of less-developed

SACRAMENTO MINE.

properties which need only capital to put them in the shipping list.

It is gratifying to know that, besides Colorado capital, outside money is beginning to find its way in from Boston, New York, Chicago, Pittsburg, Iowa, etc.

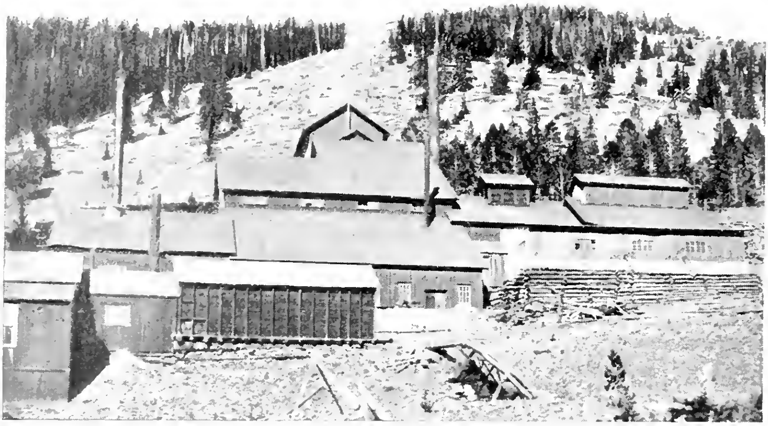
Pitkin was a great silver-producing district prior to 1893, and the Cleopatra and Fairview mines (altitude, 12,000 feet) compare favorably with the very best mines of Aspen and Leadville, as, owing to the extreme richness of the ore, they have never ceased shipping. If silver is remonetized, Pitkin will enter upon an era of great prosperity. In Chicago Park, near Pitkin, a few years ago, two holes

PITKIN, FROM CHICAGO PARK.

were bored nearly 1,000 feet deep, penetrating much the same strata as at Aspen, but revealing three rich ore zones instead of one. The fall in silver in 1893 prevented shafts being sunk at the bore holes. Within a short distance is a similar basin,—Hall's Gulch,—where bore-holes revealed equally good prospects. Such investigation demonstrated the fact that in the vicinity of Pitkin are two of the largest silver-ore basins as yet known in Colorado, both practically virgin ground.

Between Pitkin and Tin Cup (altitude, 10,200 feet) are a number

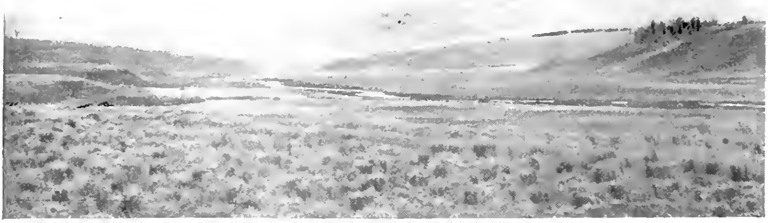
CLEOPATRA AND FAIRVIEW MINES; ALTITUDE 12,000 FEET.



BRUNSWICK MILL AND JIMMY MACK SILVER MINE (CLOSED DOWN).

of silver mines now shut down by the fall in the price of silver, including the Jimmie Mack Mine and Brunswick Mill, representing about $180,000 of New Jersey capital; the Gold Cup group, representing about $350,000 of New York and Colorado capital; the Tin Cup mine, owned in Kansas City; El Capitan mine, owned in Illinois; the Carbonate King and Queen, owned in Kansas City and New York; the Iron Bonnet mine, owned in New York; the Napoleon, owned in St. Louis, etc.

There are to-day more men at work in the Tin Cup district than



TAYLOR PARK.

ON FOREST HILL; ALTITUDE 10,500 FEET.

in the Pitkin district, many of them being employed in the placers in the vicinity of Tin Cup, which are very rich and have been worked for many years, though only by hand,—that is, without any appliances involving the investment of considerable capital.

North of Tin Cup is Taylor Park, an undulating, grassy valley,

MINE ON CLOSE MOUNTAIN; ALTITUDE 12,200 FEET.

THE MILL AND CABINS, CROSS MOUNTAIN; ALTITUDE 10,000 FEET.

THE LIVING QUARTERS, CROSS MOUNTAIN; ALTITUDE 10,000 FEET.

twenty-eight miles long by eight miles wide, with an average altitude of over 9,000 feet, surrounded by snow-crowned peaks ranging from 13,000 feet upwards, and drained by Taylor river and its tributaries,—all splendid trout streams. The billowy character of the park is due to the fact that it was once the site of an immense *mer de glace* fed by tributary glaciers from the amphitheatres in the adjoining ranges, and that these various glaciers deposited moraines, which now constitute the low rolling hills in the park: further, there is evidence of two distinct glacial periods with intervening lake period.

In Taylor Park, at a point ten miles from Tin Cup, we visited the headquarters of a most interesting enterprise. Massachusetts capitalists some time ago employed a noted California placer expert to examine and report upon Taylor Park. He spent several months on the ground, and his report was most favorable. To make quite certain, however, other experts were subsequently employed, and their independent reports confirmed the report of the Californian. Thereupon a company was organized with Massachusetts capital, about three thousand acres of ground were secured, and a ditch is being built from Taylor river 17 miles long, 8 feet wide on the bottom, 10 feet wide on the top, and 3 feet deep, with a fall of 15 feet per mile, carrying 2,000 miners' inches of water, the total cost of such ditch being estimated at $38,000. A second ditch is being built from Texas Creek 6½ miles long, 5 feet wide on the bottom, 7 feet wide on the top, and 2½ feet deep, with a fall of 20 feet per mile, the total cost being estimated at $12,000. It is expected to have the small ditch completed by the middle of September, and the big one before snow falls. Next spring these two ditches will furnish water for hydraulic placer-mining on an extensive scale. The lowest estimate of any of the experts as to the gold in the gravel is 25 cents per cubic yard. One single gulch, Hall's gulch, 1 mile long and 600 feet wide, is expected by the experts to yield $2,000,000 in gold, and this represents only one-tenth of the area of the company's ground. The company is putting up a sawmill, as it expects to use 339 000 feet of lumber for flumes, and 1,600 cords of lumber for riffles.

The details of the operations of this company are given, because, according to the best information that can be obtained, there are at least over 200 square miles of gold-bearing gravel in and around Taylor Park, which pans gold almost anywhere. The company representing Massachusetts capital is the first organization that has ever approached the matter with capital on a large scale. It has only a fraction of the ground, and what it is now doing others have every opportunity to do in adjoining places.

The question arises: Where did all this placer gold come from?

Strange as it may appear, although the existence of these immense placers has been known and some portions of them have been worked in a superficial kind of way for thirty years, there does not seem to have ever been any persistent or thorough effort to prospect the ground at the head of the gulches for veins. While the gold may have come from the disintegration of mineralized rock too low grade to be profitably mined, the probabilities are that much of it came from the breaking of high-grade gold-bearing veins now covered up by *débris* : and the Massachusetts company, in hydraulic mining down to bed-rock, will possibly discover some of the original veins.

We also visited Forest Hill (altitude, 11,000 feet) on the west side of Taylor Park, about 20 miles north of Tin Cup. On this hill, even to the crest, three different companies, representing Minneapolis, Michigan, and Ohio capital respectively, are operating. Very rich float has been found on the hill, but, so far, the veins from which it came have not been discovered, and the Minneapolis company is the only one that has yet found veins at all,—*viz.*, one averaging about $30 per ton, and another only just struck, averaging $60 per ton.

We also visited Cross Mountain, seven miles from Tin Cup, the developments on which are destined to have a very important effect on the district. An eastern gentleman, with previous mining experience, went to Cripple Creek in 1894 and spent some months looking for an investment, but finally, disgusted with the high prices asked, left without investing in anything, moved to Gunnison county, and eventually secured some claims at an altitude of over 12,000 feet on Cross Mountain, under lease and bond. He commenced work August 1, 1895, and found considerable ore that panned and assayed well. He put in a two-stamp Tremaine battery, and in fifteen days ran through it 151 tons of ore, the result being very satisfactory. The ore averages from $65 to $70 per ton, and he saves from 65 to 70 per cent. of the assay value on the plates. During the past winter he has continuously employed eighteen men and an assayer, there being a complete laboratory at the mine. The assayer has made numerous careful tests of the tailings from the mill, the results showing that, with cyanid, from ninety to ninety-five per cent. of the assay value can be saved ; a small cyanid plant is now being erected. At the time of our visit there were 600 feet of workings, all in ore, and 1,800 tons of ore on the dump. A wire tramway will be built for conveying the ore from the mine to the mill, over 2,000 feet below, so as to dispense with the pack animals now used. The capacity of the present mill will be increased, and, by means of the cyanid plant now being erected, only the bullion will have to be shipped. The country rock is lime, the foot wall being blue lime and the hanging wall dolomite. The vein varies from eighteen inches to seven feet in width. There are four different places on the property where a shift of men can be set to work on ore, and which apparently belong to the same ore body.

Not only is this property in an entirely new district, but, from the top of Cross Mountain above the mine, the same geological formation can be distinctly traced for miles to Fairview Mountain, where are the great silver mines,—the Cleopatra and Fairview before mentioned; yet such continuation at the time of our visit was practically unprospected and unstaked. Since our visit, however, encouraged by the success of the owner of the above mentioned property on Cross Mountain, prospectors have gone into the district, and several very important new discoveries have resulted.

The eminent geologist who accompanied the writer in the tour through the northern end of the belt sums up the district as follows:

There is a gold-bearing area in the granite rocks between Ohio Creek and Quartz Creek near Pitkin, which promises well and already has some good mines.

There is a grand future before Pitkin and its silver basins of Chicago Park and Hall's Gulch, if silver again comes to the front.

Tin Cup also will again look up with any marked improvement in the price of silver, but the strength of the Tin Cup region lies now in its splendid and scarcely-touched placer fields.

Cross Mountain shows, as at Leadville, how a contact zone, at one point supposed to be only silver-bearing, may at another point pass in to gold, and reveals the presence of a gold belt which has, as yet, been little prospected and is apparently capable of much further extension.

It is not possible in a single article to give all the encouraging things we saw, or the interesting data we collected, but, from personal examination during the two trips in question, aggregating 290 miles, the writer has no doubt whatever that, if practical men with capital would examine the district for themselves and invest their money on the business principles adopted in some of the cases quoted, the results would be highly satisfactory to the investors.

The above, however, is not the only young district in Colorado, and the point to be enforced is that eastern capitalists seeking *bona fide* mining investments on a business basis would act wisely in personally investigating some of these undeveloped districts of undoubted merit, rather than rashly pay inflated prices for properties in "boomed" districts.

THE ECONOMY OF THE MODERN ENGINE ROOM.

I.—THE PROBLEM OF BOILER SELECTION.

By Charles E. Emery.

THE elementary principles involved in the construction and operation of a steam boiler are of the simplest character, and may be deduced from the ordinary operation of boiling water in a kettle over an open fire or upon an ordinary stove. In fact, if an ordinary tea-kettle containing a little water have its cover tightly closed, it typifies a steam boiler. If the outlet through the spout be free, the steam formed will escape at atmospheric pressure and a temperature of 212° : if the outlet be closed, the pressure will rise as well as the temperature of the water and steam, and this operation will continue until an explosion takes place, unless the steam is permitted to escape as fast as formed after the desired pressure is reached. This is accomplished, in the case of the steam boiler, by admitting the steam to the piston of a steam engine or to radiators for heating buildings, or by releasing it through the familiar safety valve. The kettle may be so placed in relation to the fire that steam will be formed at times with such rapidity as to carry water out with it : the same operation occurs with steam boilers, and is known as "priming."

Although the principles of construction and operation of the kettle and steam boiler are the same, the details are very different, on account of differing conditions. First, as to operation : the kettle is to be boiled but a short time, and may then be removed to a cooler position in the fireplace or upon the stove, so as to permit other cooking operations to go on, while the fire, though sometimes regulated, is generally maintained at maximum intensity, so that, when little cooking is being done, there is a great waste of heat up the chimney. On the contrary, the purpose of the steam boiler is to maintain steam pressure for long periods, and to utilize all the heat in the fuel as nearly as possible. If we suppose all the holes in the cover of a cooking stove filled with kettles containing water, evidently a large proportion of the heat of the fire will be absorbed by the water in such kettles, but in different degrees. Those directly over the fire will necessarily receive the most intense heat by direct radiation from the incandescent fuel, while the kettles farther back will be heated principally by the escaping products of combustion which give up heat and are thus cooled as they approach the chimney. The rate of transfer of heat to the several kettles will decrease progressively as the temperature of the gases falls from exposure to the successive kettles. If all the kettles be united in one, the operation will be exactly the same; the greatest quantity of heat will be transmitted to the water nearest the fire, and the heating operation will be less intense as the products of combustion approach the chimney. If, as in some stoves, a direct draft be opened, making a short route to the chimney, the kettles or heating surface along the route will be heated, while other kettles or other portions of the heating surfaces over which the products of combustion are not required to pass will receive little or no heat. The heating surfaces along the route taken by the gases will be efficient, but in different degrees, depending upon the heating surface encountered and consequent cooling of the gases between the fire and the chimney, while the surfaces over which the gases are not required to circulate will be inefficient.

The underlying principles of boiler proportions may be gathered from these simple illustrations. All the heat of the fire not directly radiated to the heating surfaces surrounding the furnace is carried by the products of combustion, and represented by the high temperature of the same; and such products must be passed in immediate proximity to other heating surfaces of the boiler, through which the heat is transmitted to the water and the gases correspondingly cooled. In general, the heating surface is increased so as to reduce the temperature of the gases to the lowest point consistent with a sufficient draft. The best boilers are so proportioned that all the surface is efficient, though in different degrees,—due, as explained, to the lowering of the temperature of the gases as they move toward the chimney. There are, however, plenty of poorly-designed boilers in which, at some part of the circuit, the gases are not distributed uniformly over the heating surfaces, and in which there are short cuts enabling such gases to take a direct course, as illustrated by the stove; making the portion of the heating surface encountered efficient, but leaving large areas of the normal heating surface over which the gases are not forced to circulate, and which, therefore, are inefficient. The evaporative efficiency of such a boiler is not as high in proportion to the total surface as one in which the gases are distributed over all the surfaces with substantial uniformity.

The general features of construction of a steam boiler are: first, a "furnace," in which the fire is made; second, a "combustion chamber," for the thorough mixing of unconsumed combustible gases from the fuel with the surplus air that has passed through the grate, thereby completing the combustion; third, a large area of "water heating surface," generally formed of tubes; fourth, in some cases, "superheating surface," for heating the steam; lastly, an escape for the products of combustion, generally a chimney of considerable height to produce the requisite draft.

The furnace may be described as a "fire-box," and is often so called, the fire being usually built upon grates directly under cylindrical boilers or inside marine and locomotive boilers. An "ash-pit" is provided below the grate. For "hand firing" of "anthracite" or "semi-bituminous" coals the construction of the furnace is simple. For externally-fired boilers, the side walls, the front about the fire door, and a low wall limiting the length of the furnace, called the "bridge wall," are fire-brick. With internally-fired boilers the fire is enclosed by metal plates in contact with the water in the boiler. For burning highly bituminous coal a fire-brick arch is arranged above the fire to prevent chilling the products of combustion before they arrive at the proper temperature for full ignition. Automatic firing apparatus is largely coming into use, particularly for soft coals, in which the grates generally incline rapidly from the fire door, and the coal, which is shoved in at the front by some form of feeding device, is gradually worked down the grate by a slight movement of alternate bars effected by a small engine. In one form the coal is mechanically pushed up from below, and in another the air is admitted from above and drawn downward through the bed of coal lying upon grates formed of pipes containing water. Each of these forms has a special value for burning particular kinds of coal.

The "combustion chamber" may be wholly or partly in the furnace proper above the fire, or may be partly a chamber in continuation of the furnace, which is frequently turned upward, forming a so-called "uptake," or large passage connecting the furnace with the tubes.

The tubes of land boilers generally run horizontally through the lower portions of the shells of "cylindrical boilers," or vertically through the water in "vertical tubular boilers." In "marine boilers" tubes of different sizes are employed. The products of combustion pass from the upper part of the furnace, forming a combustion chamber through large tubes called "flues," thence through a connecting chamber or uptake to smaller tubes, and thence by another connection or uptake to the chimney. This is called a "return tubular boiler," and in some cases several returns are employed. In some forms of marine boilers, and in land boilers of the sectional type, the products of combustion are passed across or along tubes containing water. In marine boilers such water tubes cross large flues, generally rectangular, arranged inside an outer shell. In sectional boilers the tubes are collected in headers, which in turn connect at either end to drums in which the water-level is located. In boilers of this kind the gases are directed over different parts of the heating surface by means of fire-brick partitions. In some cases such gases are required to cross long tubes several times before reaching the chimney, or to make several circuits back and forth along the tubes between fire-brick partitions laid upon the same.

In some boilers the escaping gases pass through tubes or flues, or between tubes in the steam space, so as to evaporate any moisture contained in the steam, and "superheat" the steam, or raise it above the temperature due to the pressure.

The draft is usually produced by a comparatively high chimney, but at times a shorter chimney is employed, and the necessary draft induced by jets of steam or by a suction-blower in the stack. More frequently the draft is increased by forcing air at moderate pressure under the grates, by means of a fan-blower.

In order to secure the best results, the several parts above described must be properly proportioned. Definite rules for "boiler proportions" have been established for a number of years for marine boilers, and most of such rules are applicable to all kinds of boilers, but many novelties of construction, both in the internally-fired and sectional types of boilers, have been introduced, which in many cases fix some of the governing proportions, so that the existence of any rules on the subject has been entirely lost sight of in many quarters, and questions long since settled are being tried over and over again in practical work, frequently with unsatisfactory results.

We have already shown that, to secure economy, the gases should be distributed uniformly over the heating surfaces. In some of the sectional types of boilers it is exceedingly difficult to do this without so obstructing the passages that accumulations of ashes, etc., cannot properly be removed. It is, however, apparently easy to design a tubular boiler originally so that the gases will be uniformly distributed. The tubes are of the same size and of the same length, and it seems that, by properly proportioning the connections, the difference in pressure at the two ends of the tubes, caused by the draft, could be made the same, so that the same quantity of gases would be driven through each tube, and therefore uniform and consequently maximum action obtained for the heating surface employed. Frequently no attempt is made to accomplish this result, and very slight misproportions will make a very considerable difference in the efficiency. Even with very large connections, permitting only slight differences of pressure in different parts of the same, it is found in practice that in many cases more of the gases pass through the lower tubes than the upper,—a thing which has been overcome to some extent by putting ferrules or small rings in the ends of some of the tubes, so as to prevent free flow of the gases to the tubes having the greater draft. The more philosophical way, however, as determined by practice, is to reduce the area of the tubes as a whole, thereby increasing the "resistance," so to speak, so that the gases cannot be readily carried by a few tubes, but are forced to distribute themselves throughout all the routes to the chimney. Moreover, with the higher resistances, small differences of pressure in different parts of the connections do not so much affect the results.

It was found at an early date that boilers built with a certain ratio of "cross area of tubes" for draft to "grate surface" did better than others of different proportions, and that, with a certain fixed relation of cross area of tubes to grate surface, the evaporative efficiency of the boiler could be pretty well forecast from the proportion of heating surface to grate surface. For anthracite coal consumed at the rate of twelve to sixteen pounds per square foot of grate, the cross area of tubes for draft should be about one-eighth of the grate. For bituminous coal one-seventh or even one-sixth the area of the grate is permissible. For marine boilers there is generally provided twenty-five square feet of heating surface to one of grate, but in different types of boilers this proportion is much varied, with results that will be explained later.

The simple rules above given apply only to the rate of combustion per square foot of grate stated, so that in all cases the proportions are better referred to the average amount of coal burned per square foot of heating surface. The grate in any case must be of such size that the desired quantity of coal, to produce the requisite quantity of steam, may be readily burned with the draft available. This may be readily calculated from the fact that ordinary boilers will evaporate eight pounds of water per pound of coal under actual conditions, and that nine pounds of evaporation, and occasionally ten pounds, may be obtained with boilers of the best proportions using the best fuel, while, with coals of less calorific value or boilers of less efficiency, the evaporation falls to seven or even six pounds. The grate is usually made of such size that nine to ten pounds of coal are burned per square foot per hour in land boilers, twelve to sixteen pounds in marine boilers with natural draft, and twenty to thirty pounds in marine boilers with forced draft, whereas in locomotives, where the size of the grate is necessarily restricted, as high as one hundred or even one hundred and fifty pounds of coal are frequently burned per square foot of grate area. The rate of combustion per square foot of grate makes little difference in economy, when the thickness of the bed of coal is proportioned to the required draft and the fire is not allowed to burn in holes or with irregular intensity at different points.

Practically, however, the fires cannot be so well attended to at high rates of combustion, and waste results. So also, when the grate is too large, thereby requiring a low rate of combustion per square foot of grate, it is difficult for the fireman to obtain a uniform fire in different parts of the grate, and holes are liable to burn through, admitting cold air above the fire, which affects the economical results.

On account of the variation in the quantity of coal burned per square foot of grate, the cross area of the tubes for draft should be such that one hundred to one hundred and twenty pounds of coal and upward will be burned per square foot of cross area. The area of the passages leading to the tubes is generally fifteen to twenty-five per cent. greater than the joint area of the tubes themselves, and, to reduce friction, generally the area of the uptake leading to the chimney is made in about the same proportion. The smoke pipe or chimney, however, need not be so large proportionally, for the reason that there is less friction in a single large pipe than in a number of small ones.

The proportion of heating to grate surface varies in different types of boilers. For the old-fashioned cylinder boilers fired externally, containing no heating surface except that of the external shells below the water line, there is generally but ten to twelve square feet of heating surface per square foot of grate. With flue boilers,—which term distinguishes horizontal cylinders upon which the products of combustion impinge externally below the water line, the gases returning through large flues,—there are usually but fifteen to seventeen square feet of heating surface per square foot of grate. For boilers containing a large number of flues or tubes the proportion of heating surface to grate rises to 22 and 25 to 1 for many purposes, and, particularly for small tubes, is increased to 30, and sometimes 40, 50, and 60, to 1. As the quantity of coal burned is practically the same per square foot of grate in each case, the quantity of coal burned per square foot of heating surface for the boilers with a low proportion of heating surface is very much larger than for those with a higher proportion; and at first blush it would seem that the cylindrical and flue boilers would be very much lacking in economy, for the reason that all the heat in the gases would not be absorbed and a large part would pass to waste in the chimney. This is true, but not to the extent indicated by the relative proportions, for the reason that the heating surface over the fire and that exposed to the hotter products of combustion near the fire are so much more effective than that to which the products of combustion are exposed when partly cooled, as explained already in the case of the kettles. In an ordinary boiler the furnace, containing only about one-twelfth of the total heating surface, evaporates fully one-half of the water, and the remaining eleven-twelfths of the surface less than one-half of the water. As illustrative of the decrease in efficiency rather than an exact statement, it may be stated approximately that, if five pounds of water were evaporated by the heating surface in the furnace, the remaining surface would evaporate about four pounds, of which the surface nearest the furnace and equal to the area of the surfaces therein would evaporate substantially one-half, or two pounds of water, making six in all. An equal amount of surface added would evaporate about one-half as much as that preceding, or one pound, making seven in all, and additional areas would evaporate successively $\frac{1}{4}$ lb., $\frac{1}{8}$ lb., $\frac{1}{16}$ lb., $\frac{1}{32}$ lb., and so on, so that a surface eight to twelve times that in the furnace would cause an evaporation of not quite eight pounds. This progression is somewhat more rapid than actually obtained in practice, but shows that the saving by increasing the heating surface may be so small as not to be warranted.

We have approached the "Problem of Boiler Selection" by stating in an elementary, but elaborate, manner the principles underlying the operation of a steam boiler. An article of this kind should be, in a sense, educational, and, therefore, indicate the highest aims, as well as the reasons why they may not in all cases be attained. We have, therefore, pointed out that a steam boiler should absorb as much heat from the fuel as is practicable; that, in order to do this, a large area of heating surface is necessary; that, in order to make this heating surface efficient, the products of combustion must be uniformly distributed over the heating surface, and the passages in some cases be contracted so that the gases will be forced to divide among the different routes to the chimney. These cardinal principles, as we have stated, are very much neglected. We desire, however, to further point out that, in this case as in others, there are exceptions to the general rule. We have indicated correctly the proportions which should be adopted in order to secure high economy. We now call attention to the fact that, since the passages for the products of combustion must be contracted to secure high economy, it is not possible to burn larger amounts of fuel than originally provided for without some method of increasing the draft. Moreover, the extra resistance introduced prevents prompt action in case of emergency; that is, the boiler is poorly adapted to respond to an immediate demand for a large amount of steam.

It therefore follows that boilers specially designed for economy are what is called "slow steamers," available where steady power is required and not adapted for variable power. As the power is variable in many locations, a different type of boiler is necessary, and in a great number of cases what is called a "free" boiler is employed; that is, one which will, when the draft is open, burn coal quickly and furnish steam rapidly, although at some sacrifice of economy. The illustration given shows that this sacrifice is not very great, though important where economy is a prerequisite.

Originally boilers were constructed with large flues, and undoubtedly wasted fuel to some extent, but they certainly showed marvellous work in furnishing steam. A reaction occurred, and boilers were made with small long tubes; such boilers undoubtedly furnished steam very economically, when there were a sufficient number to supply the maximum demand. It was found, however, as readily explained by the table, that by putting larger tubes in the boilers very much more power could be obtained, and that the economy was so near that obtained with the boilers having longer tubes that the owners would rarely discover the difference. For these reasons most of the boilers sold regularly are of the free, uneconomical type, but they give satisfaction for the reason that they furnish the steam required promptly and without difficulty. This is true both of the ordinary cylinder tubular boilers in so common use throughout a large portion of the country, and of the sectional boilers which have more recently come into the field. Tubular boilers made free in order to supply quick demands for steam are about equal in economy to sectional boilers, but the better examples of sectional boilers can be forced farther above their rated capacity than their competitors, and are, therefore, more satisfactory where the power is variable.

The greatest success with sectional boilers has been obtained by putting in a large area of heating surface per rated h.p., and an area for draft proportioned to the heating surface. At low rates of combustion such a boiler simply does as well as other free boilers, without fully utilizing its large heating surface, but, as soon as large demands for steam are made, the boiler becomes a phenomenon compared with others rated for the same power. For high powers the gases, being greater in volume, fill the spaces for draft, and thereby make all the heating surface efficient, so that such boilers easily run at double their rated capacity, and are available through the whole range.

The subject is a broad one, but its magnitude should not discourage the reader. Some simple condition may eliminate a large number of the boilers available, so that very few need be considered in making a selection. For very small powers the vertical tubular type of boiler is best; such boilers are also made of large size, but for present purposes the larger boilers come into the general class of tubular boilers. Locomotive boilers are best suited for portable work, or where the space available makes the selection desirable even at increased cost. For larger-sized boilers used on land the selection must be made from two types,—*viz.*, tubular boilers and sectional boilers.

The form of tubular boiler almost universally employed in this country is a plain horizontal cylinder, with tubes in the lower portion and steam space above, such cylinder being set in brickwork. There are, however, vertical tubular boilers which can be used when the space available is best adapted for the same. One form of these has an interior fire-box and a large number of long small tubes communicating therewith, and is particularly designed for economy, and therefore available where the power is steady, but not for variable powers, for reasons previously explained. Another type with a small shell and bent tubes enclosed in a shell of non-conducting materials directly exposed on the inside to the heat is of questionable value for use under a large building where the protecting non-conducting shell would suggest danger from fire, but is largely employed in power stations.

The use of shell boilers is absolutely inexcusable in all dwellings and office-buildings. No matter how contracted the space, the architect should provide sufficient head-room to put in sectional boilers, the details of which are now well established. As to space, the horizontal tubular boilers set in brickwork require most, though such boilers are cheaper. The sectional boilers require more height, but, on the whole, less cubic capacity for the power developed, than any other boiler enclosed in brickwork. Where space is very much restricted, particularly in height, a greater power can be installed by the use of internally-fired boilers of the marine or locomotive type. Such boilers have been used under large buildings, as well as other forms of shell boilers, all of which are perfectly safe so long as managed properly; but, no matter how carefully the engineer and his working force may be originally selected, times of recreation and sickness either of the parties themselves or in their families will require temporary substitution of different men. Moreover, when a plant once runs smoothly, so little labor is required to keep it up that the best of men become demoralized, and occasionally dangerous conditions are established by neglect or mere oversight. The chance of accident, small as it may be, should not be taken under a building of the kind referred to. So also private owners of means should not for an instant think of taking any chances. In the country the boilers may be isolated from the dwellings, but this is not the case in many locations.

However strong these considerations may be, we cannot, in an article of this kind, overlook the fact that there are very many locations where the simple and cheap tubular boilers will answer every purpose. Manufacturers that build their own boilers will, of course, put in place the ordinary type of boiler made in their own shops, and other parties will naturally take the same course by the advice of such manufacturers. For a comparatively small steam plant, where the engineer both cares for the engine and fires the boiler, his attention is so frequently called to the latter that the risk of accident is reduced. Again, in large plants, the men operating one or two boilers have such a casual oversight over others in the same room as to reduce the risk. These considerations have their influence; so the mere question of impending danger does not prevent parties from using shell boilers, and the selection between the two types will depend entirely upon the importance attached to the different considerations above expressed.

The selection of a particular boiler from many of the same type is at times difficult for one who is not an expert. The expert knows there is little difference between them, if the work is adapted for the purpose originally, and thoroughly inspected. Those not familiar with the details can very well look over the work of the different companies on a mere business basis, and ascertain the volume of business each is doing, the kind of work the boilers are performing, and the standing of the owners as respects both business and engineering experience. It is evidently not good judgment to instal a newly-patented boiler which has not had the test of experience. There are men who will do this simply on account of difference in price and fulsome promises; so progress is not hindered by taking a conservative course and letting others have the experience. When a number of boilers are equally satisfactory, the question may be settled by the difference in price. The purchasers should, however, be satisfied, first, that they have the type of boiler they desire: second, that they have asked for bids from manufacturers of equal standing and experience; when, third, they may weigh the price with the article it is proposed to furnish.

In conclusion, we should be unfair to purchasers, and belittle the engineering profession, if we did not say that the services of an expert engineer could well be employed originally in assisting in the selection, and, finally, in determining whether the terms of the contract have been fulfilled. Perhaps the practical engineer of the purchaser may be sufficient for the latter purpose, but the various difficulties that can occur under such circumstances are best prevented by having expert assistance throughout. Advice given by contractors costs most in the end. A contract in proper form and satisfactory to one's lawyer may, if carried out to the very letter, not secure the delivery of apparatus best adapted for the particular purpose and the conditions under which operation is to take place.

For regular marine purposes the type of boiler for different classes of work has been so well established that little need be said on the subject. There has been for some time a growing desire that sectional boilers be developed for use on shipboard, and several boilers of this kind have been used for the purpose. This use, however, has not become general; so an adaptation must be based on an investigation by one well informed on the subject. The boiler on a steam yacht is always a source of anxiety. One of the ordinary marine type and of sufficient power is so heavy that many water tubular boilers have been designed to overcome the difficulty. They are not generally as substantially constructed as sectional boilers on land, but made up of small pipes put together in many ways merely to get an enormous heating surface in a small space. Such boilers always cause difficulty in a greater or less degree, and the average yacht owner, after selecting a boiler, appears unwilling to tell of its shortcomings to other owners. It is, therefore, desirable to consult some one who has technical information as to the failures of different types, and the conditions under which a reasonable degree of success has been secured in other cases.

RAILWAY POOLING AND THE REDUCTION OF FREIGHT RATES.

By H. T. Newcomb.

THE term "pool" has been popularly, though somewhat carelessly, applied to certain arrangements between railway carriers having for their object the elimination from the cost of operation of the wastes inevitably incident to competition for traffic, and the prevention of the unjust discriminations ordinarily employed to divert business from rival lines.

Pooling contracts may be defined as those which provide for the division between two or more railways of traffic which might be carried by either, or all or a portion of the earnings therefrom in proportions set forth in the contract or determined in accordance with its terms. Contracts for the division of revenue, whether gross or net, are termed "money pools," and had existed in England for many years before being introduced in this country. "Tonnage pools" aim to secure the physical division of common business, diverting traffic from lines in excess to those which have received less than their agreed share of the aggregate tonnage. This class of pools originated in the United States, and had for its chief example the famous West-bound Trunk Line pool, which included all freight shipped to the west from New York city.

The period during which the expedient of pooling was commonly resorted to by the railways of this country began in 1870, and ended early in 1887 with the passage of the interstate commerce law, which forbade all traffic or money pools of interstate traffic. During this period the number and importance of these contracts multiplied rapidly, until at its close they had become the most conspicuous feature of the administration of the American railway system. It is not surprising, therefore, that the practice received an unwarrantably large share of the suspicion and distrust with which a large number of the inhabitants of the newer States viewed the methods of railway management then current, and an excessive portion of the denunciation and invective of those demagogues who sought to profit by that feeling, just as a few decades earlier their prototypes had profited by the popular enthusiasm for railroad construction. Though the essential principle upon which pooling is based had received the approval of nearly every intelligent student of transportation, and railway managers regarded the continuance of the system as the only effective safeguard against general bankruptcy among railway corporations, popular distrust was victorious, and the interstate commerce law, every substantial requirement of which, save one, was clearly intended to protect the public from the ordinary and natural results of competition in the conduct of interstate railway transportation, was burdened by a provision which deprives the railways and the public of the benefit of the most successful restraint upon illegitimate competition ever devised, and is in irreconcilable conflict with every other feature of the law.

Immediately upon the passage of this law all pooling arrangements were discontinued, and there is sufficient evidence that nearly all railways sought in good faith to observe its provisions. Associations were formed with the avowed objects of securing the maintenance of reasonable rates and assisting in the enforcement of the new law. The coöperation of weaker lines was purchased in many cases by permission to charge slightly lower rates than those received by rival lines. Subsequently efforts were made to effect the satisfactory division of traffic without its actual transfer from one line to another after consignment, and without resort to the methods technically characteristic of tonnage pools: but the practical failure of these measures is now generally recognized, and the patrons as well as the owners and managers of railway properties are now urging a modification of the interstate commerce law that will permit agreements for the apportionment of traffic, when carried out under strict supervision by public authorities. This change was recommended by the sixth annual convention of State railroad commissioners in a resolution passed by an overwhelming majority; the recommendation was endorsed by a conference of representatives of the boards of trade and other commercial organizations of our principal cities, and has received the approval of individual members of the interstate commerce commission and of the author of the anti-pooling section of the present law. A bill embodying it, and including also several very necessary amendments to the interstate commerce law which were greatly desired by the commission, passed the house of representatives during the last session of the fifty-third congress, and would undoubtedly have received the support of a large majority in the senate, had not the rules of that body and the lateness of the session, combined with the obstructive tactics of a numerically insignificant minority, prevented its friends from securing a vote upon its passage.

Opposition to this change comes from those who are the beneficiaries of the present system through their ability to take advantage of railway competition in such a manner as to secure lower rates than those accorded to their business rivals, and from those who believe that it would affect the charges for railway service in a way detrimental to the general public. The interest of the first class of opponents is so clearly antagonistic to that of the great majority, and the profits of those who compose it are so evidently the result of injustice to their commercial rivals, that they need not be considered. As no one has ever contended that the elimination of railway competition tends to *produce* unjust discriminations, it may be taken for granted that the possible exaction of exorbitant and excessive charges is the obnoxious result of pooling which is anticipated and feared by those of its opponents who are not selfishly interested in the perpetuation of a system under which they receive undue favors. That there is no substantial basis for this claim may reasonably be inferred from the rapid decline in railway charges during the period when pooling was permitted. According to Mr. C. C. McCain, for many years auditor of the interstate commerce commission and the foremost authority on transportation charges in the United States, the average rate per one hundred pounds on freight from New York to points west of the termini of the Trunk Lines was 53.7 cents in 1878, the second year of the existence of the Trunk Line pool. In 1886, the year before the interstate commerce law took effect, the average charge for the same service was 42.6 cents, and in 1892 it was 41.5 cents. In other words, during the period when this traffic was pooled the charges declined at the rate of 2.59 per cent. per annum, but, after pooling was prohibited, the rate of decline dropped to 0.39 per cent. for each year.

The following table shows the average charges per ton per mile for all traffic carried by the important roads named during the years 1876, 1886, and 1894.

Companies.	Average rate per ton per mile in cents.		
	1876	1886.	1894.
New York Central & Hudson River R. R.	1 05	0.76	0.73
Michigan Central R. R.	1.03	0.69	0.67
Lake Shore & Michigan Southern Ry	0 82	0.64	0.59
Chicago, Milwaukee & St. Paul Ry	2.04	1.17	1.04
Chicago & Northwestern Ry	1.95	1.19	1.08
Chicago, Rock Island & Pacific Ry	1.91	1.07	0.99
Chicago & Alton R. R.	1.63	0.06	0.63
Louisville & Nashville R. R	1.85	1.10	0.88
Southern Ry	3.46	1.93	1.13

1876 was the year of the formation of the Southern Railway and Steamship Association pool, the last year before the organization of the Trunk Line pool, and the sixth year of the Chicago-Omaha pool. 1886 was the last year during which pooling was legal, and during the interval all the companies named were parties more or less continuously to pooling contracts covering portions of their traffic. The statement not only shows that the average decline was much greater during the earlier than during the later period, but also affords ground for a reasonable inference that it was confined to no one class of traffic, either competitive or local, but was distributed over the entire business of each company.

Those who intelligently seek the cause of this decline will not find it in competition between different railways, or even in the strife between carriers operating over lakes, rivers, and canals on the one hand and railways upon the other, but rather in the rivalry of different individuals or localities seeking to supply the same market. Constant and enormous pressure is brought to bear upon those officials whose duties include rate-making, and seemingly insignificant concessions in the price of transportation are solicited or demanded with a persistence difficult for the uninitiated to realize. A reduction of a few cents, or even of a fraction of a cent, per one-hundred pounds will often open new and extensive markets to the products of particular localities, and, if not immediately balanced by corresponding reductions in the rates from other sources of supply, may enable its shippers to monopolize what was formerly a common market. Each large shipper continuously endeavors to obtain more favorable rates than those accorded his rivals in the same locality, and thus to secure an advantage which not infrequently amounts to the difference between a gain and a loss. The use of particular commodities is often limited territorially by the freight charges from the points of production to those of consumption, and, when charges are too high on certain articles, substitutes produced nearer the points of consumption or carried at lower rates are frequently used. Similarly, the charges for passenger transportation, by limiting the distance to which agents can be profitably sent and otherwise hindering personal communication, effectively prescribe the limits of commercial interchange of commodities. Naturally, then, the entire force of commercial competition, possibly the most tremendous product of modern civilization, is found arrayed in opposition to the efforts of railway managers to maintain their charges at figures which will afford a satisfactorily remunerative return. As a result, railway charges tend constantly toward the minimum at which they will produce enough revenue to pay operating expenses and taxes and leave something—the smallest sum with which capital can be satisfied—as a recompense to those who own railway stocks and bonds. Pooling, in so far as it reduces the element of risk in railway investments and makes returns more certain, renders it possible to secure capital upon better terms. It also permits the elimination of many of the wasteful expenses incurred in order to keep up competition, and thus reduces the amount that must be raised from traffic to meet operating expenses. Reductions in the cost of transportation to the carriers, whether the result of new inventions, better methods, or increased traffic, invariably (for the reason stated above) accrue ultimately to the benefit of travellers and shippers in the form of reduced rates, or, what are much the same things, better facilities and accommodations. If it becomes possible to limit closely expenditure for advertising, to substitute joint passenger and freight offices and agencies for those separately maintained, to abolish commissions for securing passengers and freight, to forward traffic over the routes experimentally determined to be the cheapest, to abolish duplicate and unnecessary train service, and to effect other reforms the importance of which is apparent to every railway manager, the saving accomplished will benefit railway patrons far more than railway owners.

Industry is deprived of its just recompense quite as certainly by the improper and unjust relation between the charges for different services as by rates that are excessive. A manufacturer or jobber derives but little benefit from the fact that the rates upon his shipments, considered by themselves, are reasonably low, if those accorded his competitors are, either absolutely or relatively, still lower. Yet experience has taught the almost absolute certainty that competing railways will resort to personal discriminations in order to divert traffic from rival lines. The following extract from an article recently published in a periodical of high standing and wide circulation among railway officials indicates the extent to which this expedient has been resorted to since the passage of the interstate commerce law, and may be regarded as a statement *ex cathedra*:

"At present no railway man dares to assist the commission to information against another road. No company dares to be the active instrument in bringing complaint against another. It has its own record behind it. There would be retaliation, and (I say it with sorrow) there is no great company which can face having its record of the past years subjected to investigation with the new weapons which the Brown decision has placed in the hands of the commission."

Besides these discriminations between persons there are those between localities and between kinds or classes of traffic. These constitute a different class, because, while unjust discrimination between individuals can be effected only through secret deviations from the published schedules of charges, those between localities and commodities appear boldly in classifications and rate-sheets. The secret rates, rebates, drawbacks, under-billing, or other devices required to effect the former subject the shipper accepting and the official making them to fine and imprisonment, while the existence of the latter must be determined by the interstate commerce commission or the United States courts, and the only final remedies are money damages and modification of the rate schedules. Even the baldest and least plausible defence will, in the hands of a skilful attorney, serve to postpone these almost indefinitely, and at least one case decided by the commission is still pending, untried upon the docket of the United States circuit court, to which appeal was made over five years ago for a decree enforcing the order of the commission.*

Unjust discriminations between localities generally result from the fact that, however closely rival lines may parallel each other, there are always many stations that are served by but one carrier. Traffic between such stations bears an unduly large portion of the general expenses of transportation, and is not infrequently forced to contribute something to even the special expenses incurred directly for the benefit of competitive business. Localities thus discriminated against find it impossible to compete with those more favored; their merchants are restricted as to the sources from which they can draw supplies, and find their sales limited to the local market; population decreases, or remains practically stationary; and natural advantages are completely nullified.

The former president of a great western railway has declared that the entire net increase in population from 1870 to 1890, in Illinois, Wisconsin, Iowa, and Minnesota, except in the new section, was in cities and towns having preferential rates, while those discriminated against decreased in population. Unjust discriminations between commodities arise either through a desire to favor a particular shipper or the industries of a particular town or section. The balance of commerce is so delicately adjusted that even slight changes in the relation of rates may create an industry in a locality where it has never previously existed, or destroy it where it has been profitable. Thus the relation between the rates charged for moving wheat and flour determines where the former shall be ground, and a considerable reduction in the rates on the raw material, unaccompanied by corresponding changes in those on its product, might conceivably transfer the greater portion of the milling business of Minneapolis to the Atlantic seaboard and Great Britain.

These evils of discrimination being the result of competition, it is evident that the success of any expedient resorted to for purposes of relief will correspond to the degree in which it eliminates competition as a factor from the administration of the railway system. Theoretically, pooling attempts to accomplish this result by making it of no

* Since this article was written, a decision adverse to the commission has been filed in the United States Circuit Court. It is understood that an appeal will be taken, which, unless extraordinary rapidity is attained, will not reach a final decision in the United States Supreme Court for several years.

pecuniary benefit to any company to receive or transport more traffic than it would obtain under absolutely equal rates perfectly maintained. This object is attained by the diversion of traffic or earnings from the companies receiving or carrying more than their agreed proportions of the pooled traffic to those which have had less than their shares. Success in securing the desired result was not absolute in the case of any pool, because pools invariably lacked stability, and the periodical revision of the allotted percentages gave an incentive for the resort to competitive methods in the hope of obtaining an increased award. In at least one pooling contract this tendency was met by a provision that no argument for an increased proportion based upon the actual receipt of more than the agreed quota during the continuance of the agreement should be given any consideration or effect. Pooling contracts, if legalized under an amendment to the interstate commerce law, will undoubtedly be made enforceable between the parties, and, as the railways generally shared in the popular belief, prior to the passage of that act, that these contracts could not be enforced by judicial process, this will constitute an additional guarantee of the continuance of particular agreements and an important practical advantage.

From the foregoing examination of the nature and effect of pooling, it is evident that, if again permitted, it will tend to reduce railway charges through the immediate substitution of more economical methods of operation and the gradual decline of the rate of return demanded upon *actual* railway investments, and to abolish unjust discriminations by removing their principal incentive. Whether pooling will accomplish these results as effectively as other means that can be theoretically devised is beside the question. It is only important that it will accomplish them in a degree that will confer inestimable benefit upon all industries, and that it is the only means of relief from the abuse of competition now practically available.

Against these advantages there is to be offset but one serious danger, and that need only be fully understood and appreciated to be prevented by public sentiment and State legislation. The danger of speculative construction of parallel and unnecessary lines is always present when money is abundant, and becomes particularly so when the existence of a pool makes it possible to levy blackmail upon several lines instead of upon a single one. Such construction ultimately advances rates by increasing the risk attending railway investments and adding to the capital upon which interest must be paid. As its imminence under pooling need only be realized to be effectively met by legislation, it does not constitute an argument against the mitigation of the more serious evils of competition, in the only way now practicable, but only for the prompt institution of proper safeguards.

THE SHIFTING LINES OF INDUSTRIAL INTEREST IN ELECTRICITY.

By George Herbert Stockbridge.

SCIENCE has its law of conformity no less than art and theology; but the only conformity it really insists upon is conformity to nature. The written laws, the creeds of science, when applied, for example, to a proposed invention, or a new problem of practice, are used against its claims to orthodoxy, or in opposition to a given likelihood only up to the moment of success. Improbabilities science may discuss, but it is dangerous for it to point out what is impossible. Till the critical moment, however the scientific creeds operate just as strictly and coercively as the creeds of theology and art. And they are the only guide.

Take, for example, the problem of perpetual motion. Perpetual motion, if it were susceptible of demonstration at all, could be demonstrated in thirty seconds. The experiment might then be discontinued and never again attempted. Still, a competent witness could tell whether the contrivance supposed to embody it had really evaded the laws which such machines had previously failed to overcome. And, if it had, so brief a trial would have been sufficient to make perpetual motion an accomplished fact, an undeniable part of scientific history. Lapse of time is not the test. The arguments against it treat that as a mere incident. The main thing—the conclusive thing up to the present time—is that perpetual motion would be a phenomenon by itself, unclassifiable in our present categories. So far as we can now see, it would contradict the order of nature. And that consideration is positive and final against it.

And yet the *perpetuum mobile*, should it ever come, would break no laws: it would make new ones. The outlaw would become the leader of the forces of order. That is the privilege of a power of nature and of human genius acting in harmony with natural law. They compel broader classifications: in science, immediately; in other departments, more slowly. We cannot exclude Shakspere from the list of tragic writers because Aristotle lived a few centuries too soon. If Spohr's "Calvary," or Beethoven's "Ninth Symphony," or Wagner's "Tristan und Isolde" are infractions of the canons, it is so much the worse for the canons. Once the steam injector is born, a law must be passed to legitimize it. You can not say, after the fact, that it is impossible for a steam vessel to cross the Atlantic. Nor will so good an authority as Professor Le Conte, though supported by the most admirable logic, be able, it would seem, to prevent the imminent success of the "self-raising, self-supporting, and self-propelling air-ship" which he declared to be an impossibility.

I should, perhaps, have done better to select the air ship, and not perpetual motion, as my illustration, since that is even now passing from the realm of doubt and contest to the realm of fact. However, one vessel serves as well as another, so we arrive in port,—even the Flying Dutchman.

But, while science must be hospitable, inviting every new fact and admitting it with unreserved welcome, there is a period at the beginning of every science when the difficulty is to distinguish the invited guests from those that have forced their way in. Facts that are not facts are reported by ignorant or careless observers, and, where all are more or less ignorant, it is hard to be accurate with the best will in the world. This is the age of fable, the nebular period before the vaporous expansions of fact have contracted and solidified. In this period, ignorance eclipses the body of the sun, and leaves only the corona visible. Here the process of science is one of exclusion, of sifting, of selecting the kernel of truth from the mass of error. After that has resulted in the acceptance of a few facts and the construction of a preliminary theory, comes the other process of the admission of fresh facts and the gradual widening of theories and formulas.

A third stage of development has to do with the useful arts,—the sciences as applied to the benefit of the race. The development of the sciences as such is based on discovery and classification: that of the arts on invention.

These shifting stages of progress and this last-recited distinction are defined in the history of electricity and magnetism with what seems to be extraordinary clearness. The fables appear to be peculiarly fabulous, as becomes the mysterious nature of the agents. From the same point of view, the determination and the formulation of the underlying laws were and remain unequalled—certainly unsurpassed—triumphs of scientific genius. And the world does not need to be told that the embodiment of the laws in labor-saving machinery during the present century has produced effects unapproached by any other class of inventions.

To speak of invention as the embodiment—the conscious embodiment—of known laws is to beg the question from those who will have it that every great invention is really a discovery, but the facts of electrical history bear me out. Broadly speaking, the electrical arts have followed in time the period of inquiry and discussion concerning electrical principles. A source of energy that was a subject of speculation to the ancients has received its practical application to the service of man almost entirely within the past seventy years. The force of this statement is greatly modified by the circumstance that electricity, as we best know it, was practically first discovered in the year 1800. It remains true, however, that the earliest interest in it in each of its succeeding forms was a scientific interest, and that its laws were well established before the telegraph, the telephone, the dynamo, the electric light, and the electric motor came into being.

As this paper is concerned particularly with the electrical arts, it may pass over the period prior to the end of the eighteenth century with a brief word. To that period belong the lightning-rod and certain machines for the production of frictional electricity, but no other surviving appliance of any considerable value. The first great shifting of the lines took place when the voltaic pile prepared the way for the various forms of electric battery with which we are all familiar. Here was what may fairly be called a new force,—certainly a new possible starting point for the electrical arts. It was as different from the electricity of friction as water is from ice. In place of a refractory, vixenish, eruptive, sputtering energy, the voltaic pile gave us electricity in the form of a gentle, yet sufficiently powerful, current, like a placid river,—very easily controlled and giving new and enlarged capacities to the fluid. So far as all the important electrical arts are concerned, they are built upon current electricity, first known less than a hundred years ago. They would have been utterly impossible with the electricity that Franklin knew. So great a change was introduced by Volta's marvellous discovery. The only things in the electrical arts at all comparable to it in the revolutionary nature of their effects are Oersted's discovery of the effects of an electric current upon the magnetic needle, followed by Sturgeon's invention of the electro-magnet, and the later discovery by Faraday that this same current electricity could be produced by moving a magnet in proximity to a coil of wire, or the reverse. If the voltaic pile gave smoothness and flow to the electrical element known to the last century, the production of electricity by magnetism vastly increased the power of the electrical "virtue," and paved the way for still more surprising possibilities. Electro-magnetism has been the willing servant of both forms of current, and, when the reversing of the dynamo gave us a rotary electro-magnet of great power and apt design, the recent great accomplishments of electric power were already foreshadowed.

The general situation may be stated thus: First, the great electrical inventions which have made this known as the century of electricity depend for their action on the electrical agent in the form of a current. That is, they go back to the last year of the last century, when Volta, after studying most zealously the phenomenon of the twitching frog's leg noted by Galvani, invented the modern battery as an electric source. Second, the invention of a still more powerful source of electric current, as embodied in the modern dynamo-electric machine, was prefigured by Faraday's discovery already mentioned. Third, the greater portion of the epoch-making electrical inventions of the century have been embodied in apparatus made up of a combination of one or the other of these electrical sources with some form of electro-magnet. The part played by this secondary and servile element in the development of these great arts inclines us to put the slave of the lamp before Aladdin in the building of the tower. Nothing else in science, outside of astronomy and biology, is quite so full of the beauty of adaptation as these services rendered by the electro-magnet to the telegraph, the telephone, and the electrical transmission of power.

In the order of date the telegraph takes precedence. It came some forty years after the first of its main constituent elements appeared, about half that time being required to find a tool for Volta's pile to work with. But, when, in the winter of 1819-20, Oersted discovered that an electric current traversing a wire near a magnetic needle would cause a deflection of the needle, or when, a little later, Schweigger secured increased deflections by coiling the current-traversed wire about the needle, there was at hand a tell-tale instrument which had only to be connected up in circuit with a battery to serve perfectly as the indicator of a telegraph. The needle telegraph introduced in England in 1839, nineteen years after Schweigger's discovery, was, considering the state of information on the details of construction, about as speedy a reduction of the telegraph to practice as could have been expected. To Henry, and later to Morse, the notion came of utilizing Sturgeon's electro-magnet (invented in 1825) instead of the Schweigger multiplier, and this electro-magnet, as improved by Henry and others, is the responding element of the American telegraph system to the present day.

The needle telegraph of Europe and the electro-magnetic telegraph of America held the field of electrical invention without a full-grown rival for a little more than thirty years. By the end of that time the telegraph in this country had passed through a marvellous development, and brought into existence a large public interested in electrical affairs. The establishment of the first American electrical journal, about 1874, was an appeal to this public, and no other. It doubtless filled its office, but I regret to say that, among its exclusively electrical items, one would more frequently find notices of marriage between knights and ladies of the key than discussions of electrical resistance or magnetic lag. The prestige of having a special representative periodical belongs only to the earliest and the latest of the four great electrical arts of the century. There is still a telegraph weekly, though the original one changed its name and its character with the rise of the later arts and became a general electrical journal; and since 1889 there has been a monthly devoted to the interests of the electrical transmission of power.

After the telegraph arose two giant electrical industries, the telephone and the electric light, and later still came the electric railway and other power transmission. The first, in its generally adopted form, was another combination of the electric battery and the electro-magnet, and the second was the first great successful application of the dynamo-electric machine to the world's work on a large scale. Of this, and of the third, I shall speak later on. The one that challenges comparison with its predecessor is the telephone. Morse and Vail had taught the electro-magnet to write; Alexander Graham Bell taught it to talk.

In a certain romantic interest it seems to me that the two organizations resulting from these two different combinations of the electric battery with the electro-magnet take precedence over all the rest. Whether they are scientifically as fruitful is another question. I am sure that a competent historical romancer could weave a most engrossing tale from their history. Surely, if one takes into account the wonderful capacity of the operating agent for annihilating time and space, the unexampled subtlety of the instrument made to hand to do the agent's bidding, and the colossal changes brought about by the actual introduction of the telegraph and the telephone, nothing more could be desired. Take the electric telegraph, for example. It fed the jaded appetite of the world with a new sensation,—brought a new creation into existence. Before its time, as Professor Ayrton acutely observes, it was thought necessary for A, wishing to attract B's attention, to make a loud noise or show a large signal where A was, instead of making a slight noise or showing a small visual sign where B was. No other agency ever suggested the latter arrangement, although, since Xerxes's time and earlier, every conceivable element has been set to work to aid in securing the quick transmission of news. The door-knocker is a type that has been replaced by the push-button operating the electric kitchen bell. The former was the best that twenty centuries could do: the latter came naturally and quickly when the electric current exhibited its capacities. Indeed, the idea was suggested during the last century of utilizing the electricity of friction in a similar way.

In its turn, the telephone did something so contrary to human experience as to awaken universal wonder at its accomplishment. The mere statement is enough. Nobody will contest it. The telephone was essentially a complete novelty. It will be well to bear these unique services of the telegraph and the telephone in mind, when we come to consider the shifting of levels which has left them high and dry above the present scientific—and perhaps the popular interest.

When it came to the electric light, the field was already occupied. The light was new, but it had and still has a strong competitor in the gas light. There was no such excellence as to make anything else unthinkable, though with the telegraph that was the case, while nothing has yet appeared capable of posing for an instant as a rival to the telephone. The electric light simply took its place beside other means of illumination, and claimed its share of the business. The problems were those of subdivision and distribution, mainly, and the commercial one of finding a place for the concentrated light of the arc. That all are satisfactorily solved is evidenced by the present wide dissemination of arc and incandescent lamps.

The development of the electric motor industries, like that of the electric light, broke no new path. Good motors available for railway work and for running presses and other machinery were in existence long before the full growth of electro dynamics was reached. Humanly speaking, the world could better have spared the incandescent lamp and the two-phase motor than it could the quick intercommunication by the written and the spoken word furnished by their predecessors on the throne of electrical preëminence. If there were no trolley, we should perhaps be travelling to Flatbush by horse-car, or by steam, or possibly by compressed air; if there were no electric lights, we could do fairly well with gas: but what would supply the place of our office telephones, which enable us to talk with the business men of New York and a dozen other cities? and what would not civilization lose, should the electric telegraph become a lost art!

The growth of the telephone and the electric light side by side created an immense electrical public, forcing electricity into the foremost place among commercial enterprises on the one hand and among the sciences on the other. If there had been any doubt, however, about this being the age of electricity, it was totally dispelled by the advent of the electric motor and the employment of the electric current for the transmission of motive power. This is the latest and, in a sense, the greatest of the applications of electricity at the present time. Temporarily it eclipses in general interest all the other applications. The reduction of the giant power of Niagara to a few threads of flowing energy, for ease of transportation, and letting it loose a hundred miles away to run a loom or a sewing machine is scarcely less than a miracle, and it is no wonder the popular interest is aroused. The apparent disproportion between the actual performance and the insignificant means employed is a never-ceasing source of wonder. Apart from its comparative novelty, and the surpassing scientific value of the art, this is the secret of the present predominance of electric power transmission in technical literature and elsewhere. This, and one thing more. It is a rapidly-growing art. There is as yet no sense of age or decay about it,—of its having reached or passed its prime. On that claim to attention the electrical arts have each in succession held the place of honor.

I have spoken of the periodical literature of electricity. Naturally, the first purely electrical periodicals touched mainly on the telegraph, and grew rapidly in interest under the stimulus of the picturesque development of the telephone and the electric light. While those two arts were in the ascendant, the journals were occupied largely with accounts of new inventions and new installations of one or the other of these appliances. Broadly, the period extended from 1876 or 1877 to 1889 or 1890. Only since the latter dates have they distinctly receded behind the electric motor.

Still more noticeably does the trend of interest show itself in general technical or scientific periodical publications and in the daily or weekly press. Within the past six or eight years several of the daily newspapers have undertaken to give their readers a column or so a week of notes on electrical progress; and every one of the scientific magazines has an electrical department as a matter of course. In these newspaper columns, and particularly in the magazine departments, the call is now for notes or articles relating to dynamo-electrics or electro-dynamics. In the magazine offices it is difficult to secure any consideration for the most carefully-prepared papers on the telegraph or the telephone. They want the latest thing in polyphase motors or the most authoritative statement about Tesla's high-frequency currents. The telegraph is out of date. The king is dead; long live the king!

The same story is told by the transactions of the learned societies. I happen to have before me the *Transactions of the American Institute of Electrical Engineers* for 1894. Barring papers on the electrical units, electric meters, and the like, which might relate as much to a battery current as to that of a dynamo, an analysis of the volume shows the following. There are five papers on polyphase apparatus or problems connected therewith; one on the electric railway and two others suggested by the action of electric-railway currents on buried pipes or other conductors; five on dynamo-electric machines or armatures not included in the articles on polyphase currents ; one on the theory of the synchronous motor ; one on a certain type of incandescent lamps, and one on the general subject of the subdivision and distribution of artificial sources of illumination ; one on lightning arresters and recent progress in means for protecting against lightning ; one on the electric brake, and several other miscellaneous papers ; but not one on a subject directly connected with the telegraph or the telephone. The *Transactions* of the same learned society for 1893 and for 1895 show the same absence of discussion respecting the two subjects last-named,—and, I may add, the same putting forward of the problems and accomplishments of the larger electrical machinery. And there is no repetition of the sporadic reference to lightning protectors, as there was in 1894. Electric lighting itself had long been practically dead matter in the scientific printing-offices, till Mr. McFarlane Moore's recent experiments gave it a new impetus.

An instructive light is thrown on the shifting of relations in electricity by such a search as one is called upon to make in determining the validity of an electric patent, particularly in one of the older electrical arts. The prior art nearest to hand, and nearest, commonly, in time, is contained in the American and foreign patents. In general they are first consulted. Back of them, or concurrent with them, the scientific periodicals, the volumes of transactions, and the book and pamphlet literature. As one goes backward in the search, one notes an increasing proportion of disclosures in the literature of contrivances not found in the patents, while, on the other hand, the proportion of inventions described in the periodicals and transactions as compared with the scientific disputations gradually falls off. Starting from the other end of the circuit, we find the electrical literature of the early part of the century quite saturated with the controversy over the contact and the chemical theories of the voltaic battery. Slowly opinions on the scientific questions became fixed, and by just so much the growth of invention was apparently quickened.

This aspect of the case suggests one noteworthy shifting of the lines that has taken place inside the mysteries themselves. The character of the very priests of the cult has undergone a change. The scientific investigator has become an inventor. Experiments are now made with locked doors and with an eye out of window toward the patent office. The most famous "laboratory" in this country is Mr. Edison's factory, equipped with the most perfect contrivances for quick model-making under conditions of secrecy. Nothing invidious is meant by this. It is the spirit of the time. It accounts for the changes noted in the comparative amount of space given to pure science in the literature of earlier times and of to-day. Notably it accounts for the fact that, of late years, the earliest information about an invention is likely to be found in the patents. Great commercial interests might suffer, were it otherwise. The traditions of science are preserved chiefly among the schoolmen or such inventors as were formerly connected with the schools,—for the commercial instinct has invaded them also, and dragged forth some of the brightest and best to the factory. It works better that way than it does in the reverse process. On this point I have expressed myself elsewhere in terms which I venture to quote here :

"'Scientists often become inventors, but inventors rarely become scientists. Out of the large number of electrical inventors—some of them of great prominence—who have obtained their knowledge of electricity mainly from practical experience in the workshop, it would be hard to select a single example of a man who has added to the general knowledge of electrical laws and principles. This function is confined almost exclusively to those who are, or have been, laboratory workers. It may be stated broadly that the only electricians who are now devoting their attention seriously to the formulation of electrical science as such either are or have been schoolmen, and most of them bear a title indicating the teacher."

All this hints at vastly altered conditions of work for the modern scientific student,—at opportunities gained, shall we say, or lost? Gained, no doubt, in the mass ; but surely some ardent searcher, now and then, would have given us more of his best work, had he not been jolted out of his natural bent by the irresistible march of the inventive spirit. Meanwhile, if it be true that the hope of advances in electrical science rests with the schools, it is thence also that future electrical inventions shall come. Not directly, but by virtue of the expansion of science which historically has preceded the rise of the arts hitherto. A new science, a new group of arts. Is it that the science of galvanism, so-called, is exhausted that it breeds no new sons? And is our increasing knowledge of the polyphase and high-frequency currents soon to give us a perfected science in that direction? The answer to these questions may furnish some hint as to the shifting lines, if such there are to be, of electrical development in the future.

THE HARMONY OF ARCHITECTURE AND LANDSCAPE WORK.

By Downing Vaux.

THE engineer and architect have succeeded the contractor and builder in the planning of bridges and buildings in America to a very great extent; indeed, it is taken as a matter of course now, when any work of this kind is contemplated, that it will be under the control of professional men; but this is not the limit of attainable improvement, nor do we yet realize, perhaps, the full advantages which can be obtained by a still wider collaboration in initial study and the complete harmony in adjusting all the elements which should enter into a perfect and effective construction.

Where the strictly architectural and engineering work ends, there is still adjoining territory more or less under control, but too often entirely neglected, or (which is possibly worse) treated in a manner jarringly discordant with the main theme.

It is true, we have grown beyond the period when we could regard with equanimity the spectacle of a castellated Gothic building with grounds whose geometrical exactness and precise symmetry recall the proverbial "Dutchman's garden"; we are no longer content that the Corinthian columns of our city hall or the Doric front of our court house should be set down in a dreary square of rain-gullied clay, or enclosed by a red picket fence.

Much of the work, in our larger cities particularly, is admirable in every respect, and we are generally learning to demand that our dwellings and our public constructions shall be given an appropriate setting: but it is frequently found, when it is proposed thus to bring the setting into harmony with the main work, that radical changes in some important feature, which could have been easily made in the beginning, are now impossible except at great expense; and the artistic effect of the work suffers accordingly.

The World's Fair at Chicago showed so clearly the success secured by coöperation between the engineer, architect, and landscape architect that we may confidently look for so conspicuous a precedent to be followed by great improvement along this line. *There* was a successful example to be studied, doubly useful because so apparent to all, and already exerting a great and beneficial influence in the harmonizing of architectural and engineering structures with the natural surroundings.

The work of the landscape architect would be of far more value generally, if he were consulted in the beginning, as at the Chicago

Fair, and given an opportunity to suggest changes in the location of buildings, instead of, as in many cases, called in as a kind of afterthought and compelled to make the most of an unfortunate position.

By securing his assistance at the outset, the building would get the immediate benefit of such local features as the site afforded; the trees and rocks would be saved, to serve as a basis for the more extended treatment decided upon, instead of being sacrificed to the profit or convenience of the contractor; the materials removed in the construction of the work could be at once disposed in accordance with the general scheme for the treatment of the grounds, and the building and its setting grow simultaneously toward orderly completion.

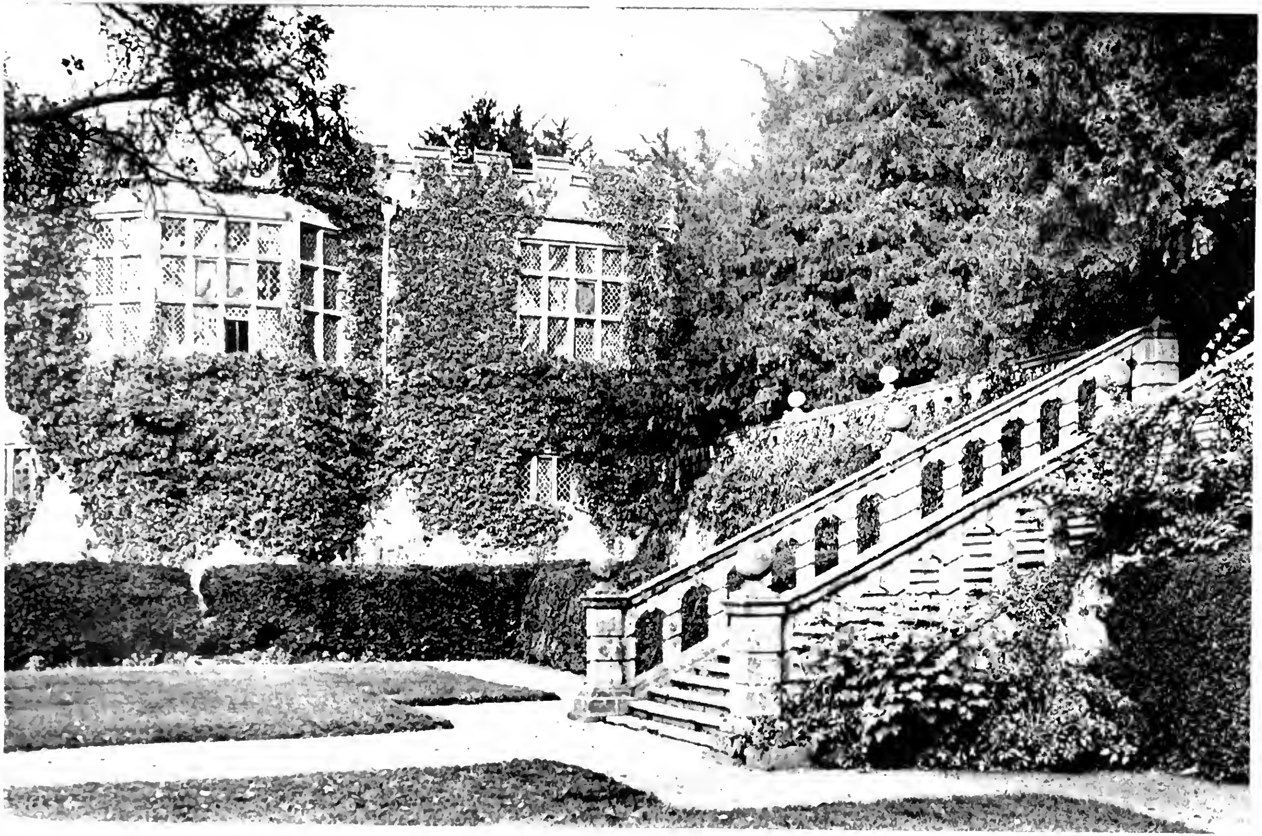
Private dwellings are, perhaps, at present more frequently designed to meet the local requirements than other structures. We occasionally see a modern country home shaded and embowered the first year it is finished; but, further than this, the intelligent study of the conditions at the start by the landscape architect would assist in placing the building in the most effective relations to its surroundings.

He would not only consider, in connection with a dwelling, how it might produce the best appearance from the principal view points, but would give equal attention to the outlook from the house itself. His aim would be to secure the best vistas from the principal living rooms or the verandas most likely to be in use in pleasant weather. He would study the site, and the opportunities it afforded for display or concealment of different portions, in relation to the life of the house, as well as to the harmony of grounds and architecture.

The architect should be willing to meet the landscape architect in the consideration of various points where the work of one merges into that of the other. Each is dependent on the other for the full completion of the picture he has in mind, and both are injured if this ideal, through lack of coöperation, is not reached.

In many cases it would be a great relief for the architect to be free from the responsibility of having to decide on the exact location of a building at a time when his thoughts are filled with the details of contracts and working drawings; and here he can be greatly helped by turning over this part of the work to a landscape architect, or, at least, by leaning heavily upon his advice and suggestion, which are most important and valuable before the final plans are adopted; for the controlling lines employed by the architect should in a measure be governed by the environment.

Where the situation is on uneven ground, the design may be relieved by a broken sky-line and entrances on the different sides at varying levels. Where the site is comparatively level, the structure



AN ENGLISH EXAMPLE.

LANDSCAPE WORK AT LENOX, MASS.

gains by the subordination of all minor features to the main motive, and the concentration of thought on that. In a perfectly level country the desire for a break in the oppressive flatness of their surroundings moves men to build high, monumental outlooks, and employ their talents in endeavoring to supply that which nature has denied them, but supplied in boundless profusion to their neighbors. So, in the work of adding to the effectiveness of buildings and making their surroundings more interesting, success is often attained by the bold

THE WHITE HOUSE AND GROUNDS, WASHINGTON, D. C.

adoption of a formal treatment, where the most can be made of lines of stately trees, well-trimmed hedges, and straight, flower-bordered walks, leading to an elaborate gate or arch. This treatment becomes especially happy when judiciously incorporated in the design for a public park, and gives an opportunity for the architect and sculptor to add to the natural beauty.

The beautiful examples so placed gain greatly in the total elimination of all surroundings that would otherwise possibly dwarf their height or interfere with light, delicate features which are brought out in strong relief by a background of foliage or a delicately-verdured

PARTERRE, SCHÖNBRUNN PALACE GROUNDS, VIENNA.

hill slope. The thoughts of the passing wanderer are led to dwell on the life work of the subject of the sculptor's chisel, and incline him to linger and admire when the surroundings suggest rest and contemplation.

The public parks of our large cities have been generally laid out and taken care of by men of intelligence and thought, and the results are most creditable. The dweller in large cities can walk along shady paths, under rustic bridges, by cool lakes, without leaving the city limits; he can ride and drive on splendid roads, enjoy the great variety of flowers and foliage growing there, and feel the harmonious blending of natural and architectural features. Just here is where the

THE "OBELISK-ALLEE," SCHÖNBRUNN PALACE, VIENNA.

architect can help in linking land and water together in the general design. The shelter can be placed among the trees along the path, and be of an informal design that will not clash with the park idea; it can be of cool tints with little elaborate ornamentation.

THE BOW BRIDGE, CENTRAL PARK, N. Y.

SHELTER HOUSE, GOAT ISLAND, NIAGARA FALLS.

A GLIMPSE OF CENTRAL PARK, NEW YORK.

THE BETHESDA FOUNTAIN, CENTRAL PARK, NEW YORK.

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The outlook or tower on the highest ground can have a slender tapering sky line that will even accent the limits, instead of dwarfing the extent of the park grounds. Not only should the bridge be a picturesque structure itself, but the abutments should be made to fit the ground, and not end in mere masonry necessities.

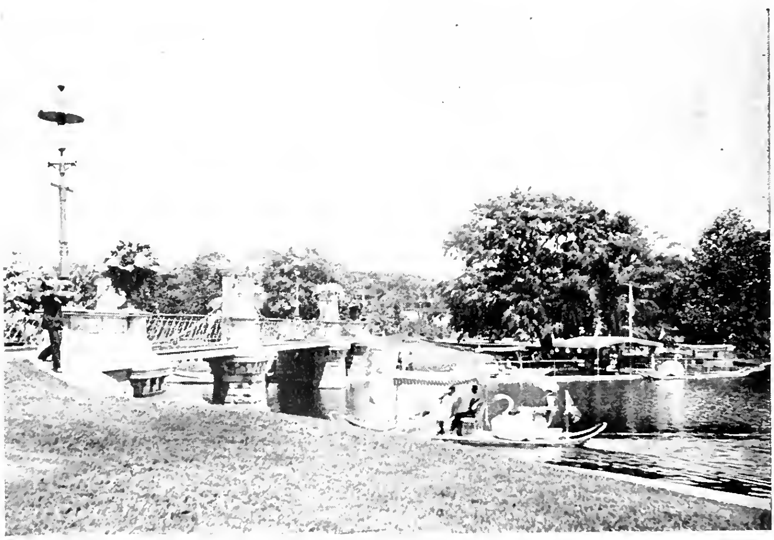
The addition of some of the bright flowering aquatic plants to the pool or fountain combines the daily variations of living examples of the most beautiful and exquisite flowers with the cool, clear effect of running water.

Where music is heard across the water, a blending softness is given to the notes that is distinctly caused by the undulating surface, and

THE BELVIDERE, CENTRAL PARK, NEW YORK.

BRIDGE AND LANDSCAPE, GOAT ISLAND, NIAGARA FALLS

LILY POND IN CENTRAL PARK, NEW YORK.



IN THE PUBLIC GARDENS, BOSTON, MASS.

THE LAKE AND TERRACE, CENTRAL PARK, NEW YORK.

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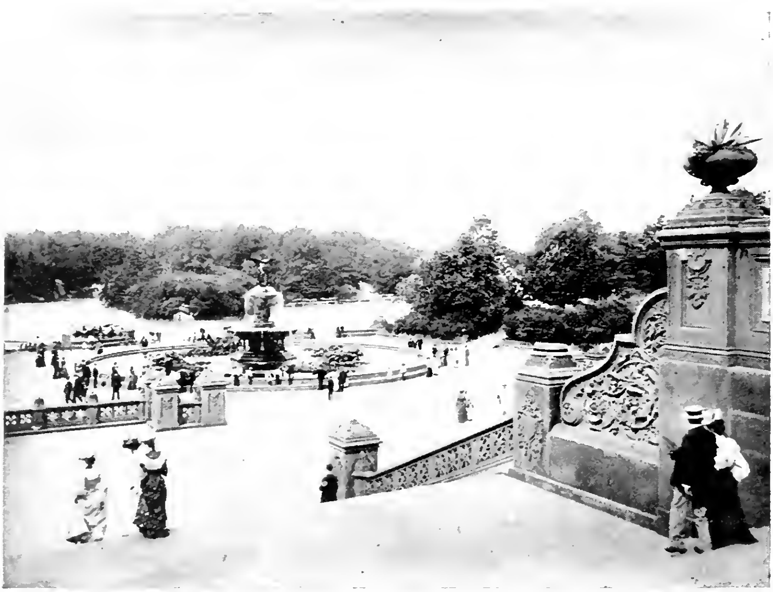
this can be taken advantage of by placing the music stand on an island. Aquatic birds add life to the water, and are seen to advantage from boats, which are more used as their benefits are appreciated.

IN LINCOLN PARK, CHICAGO.



THE TERRACE AND FOUNTAIN, CENTRAL PARK, NEW YORK.

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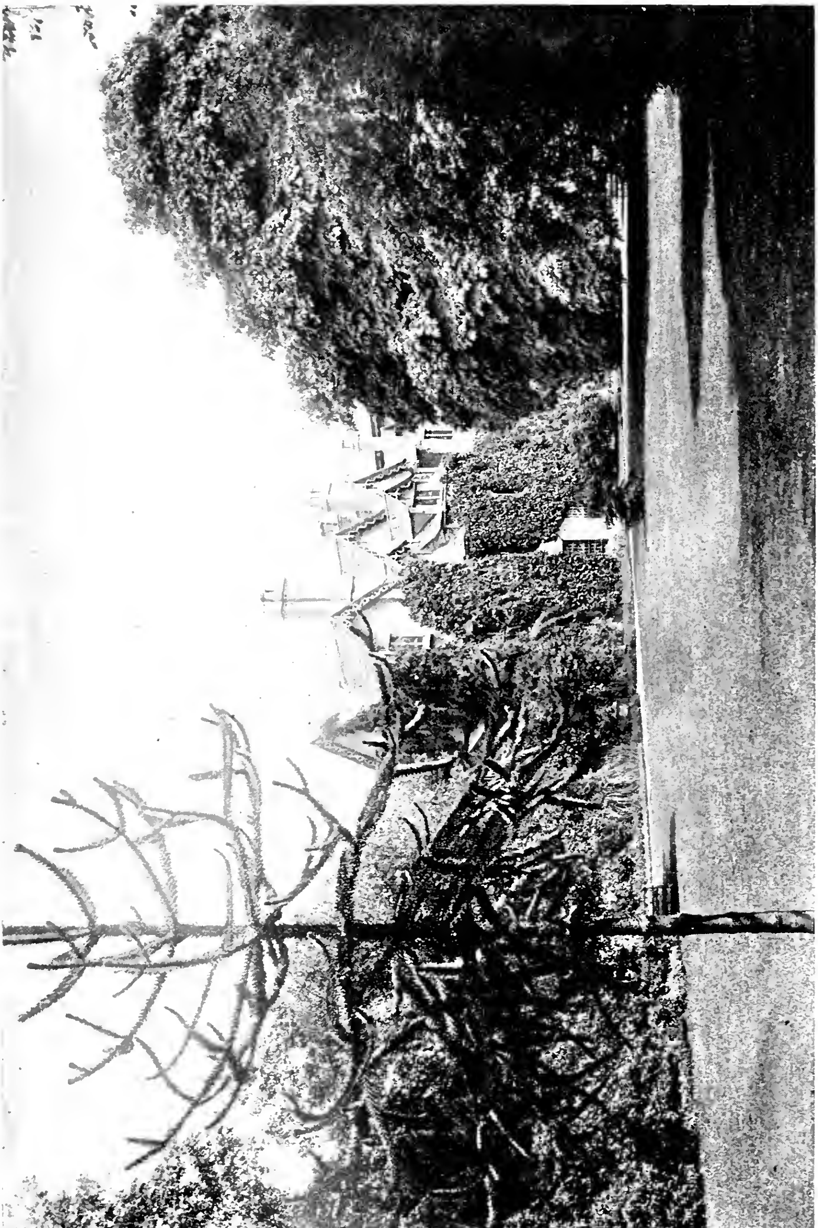
THE COLONNADE, VERSAILLES PARK, FRANCE.

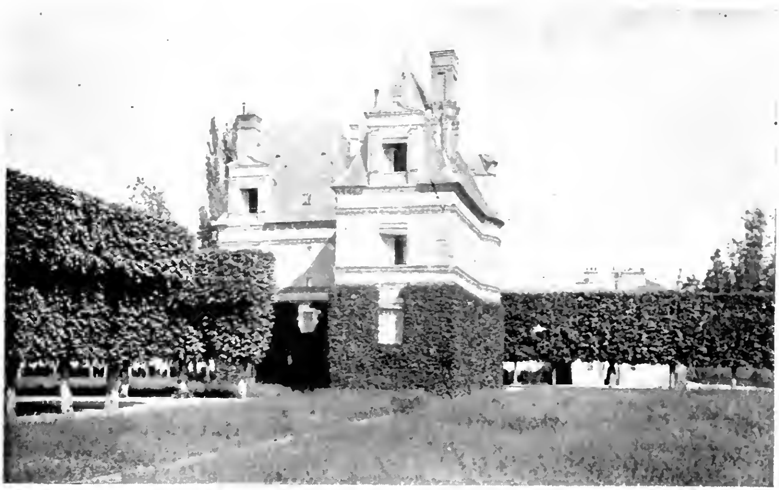
Where civilization reaches its highest development, we find that the beauty of nature is appreciated as well as the greatest works of man. The Romans had their gardens, and from the earliest times the wealthy have striven to secure parks and gardens, but the idea of beautiful breathing-spaces for the poor is comparatively modern.

In older countries, there is naturally a survival of the product of the older ideas, and the private parks of Europe represent a development which is, perhaps, hardly paralleled on this side of the water, and furnish the most striking examples extant of the blending of landscape work with architectural ornament. In Italy the formal treatment has been the favorite one,—a geometrical arrangement of

A FLORENTINE DOORWAY AND GARDEN.



IN THE GARDENS, WORCESTER COLLEGE, OXFORD, ENGLAND.



THE SULLY PAVILLION, PALACE OF FONTAINEBLEAU.

walks, adorned with marble steps, balustrades, vases, statues, seats, and arbors. In France the ingenuity of the designer is given great latitude in constructing grottoes, elaborate labyrinths of paths, and an endless variety of fountains. In Spain the beauty of the work of this kind is closely associated with the former grandeur of the builders, and often heightened by the present half-ruined condition of so many of their masterpieces.

In England, where more has been done by individuals in this direction than in any other country, the beauty of the parks and gardens is recognized the world over. The English have developed the lawn, the planted background, the surrounding sky line; they have built their castles often on the rocky shore of a lake or in a forest of noble oaks, have opened up views in various directions, and have generally adopted a broad, generous treatment in the surroundings. They have had many writers on these subjects, and several of the best works are by English authors.

Germany, famed for its castles on the Rhine, has many beautiful structures where the environment is preserved in harmony with the work itself, though in other cases their noblest examples are marred by the close contact of houses of inferior design,—notably the Cologne cathedral.

It is only in recent years that the need of preserving the surroundings of our beautiful buildings has been recognized; this has led many institutions to move their quarters from the closely-built-up portions of the cities to the more open suburbs.

The colleges especially gain by this change, not only in the greater extent and beauty of their grounds, but in the added quiet and repose of the surroundings.

The University of New York has recently moved north of the Harlem river; Columbia College is now building on larger grounds; the Chicago University has an extensive site on the lake front.

The summer hotels have found it necessary to buy extensive tracts of land in their neighborhood to secure the quiet and freedom their guests demand.

Land improvement companies are developing their property in a more sensible manner by devoting some part of their ground to trees and shrubbery.

The railroads are following the same idea, and it is not rare to find the station in a park or with well-kept grounds about it.

Some of the principles that a few years ago had to be fought for are now taken as a matter of course,—for example, the gain in the extent of grounds by the omission of private division fences and the elimination of iron boundary fences in our city parks.

Comparatively few people know that the work of the landscape architect is carried out in a thoroughly business-like way, and on the same general lines as architectural and engineering designs.

A topographical survey of the ground is first made, and from that a plan is drawn, showing the location of the proposed drives and

CLARE COLLEGE, CAMBRIDGE, ENGLAND.

THE ARTIST TOUCH OF TIME.

walks, with the buildings. The changes in the surface are shown by figures. Next a planting map is prepared, indicating the position of all trees and shrubs to be planted, and giving a list of their names. The detail drawings for special features, such as arbors, summer houses, etc., follow.

Grass-covered areas of ground are the foundation of the simplest as well as the most elaborate designs in landscape treatment. A well-kept lawn is a satisfaction in itself, pleasant to walk on, agreeable to the eye, and alive in its varying tints and growth.

A combination of harmonious colors and informal design admits of endless variety in detail; by arranging the smaller growing plants in front and the taller ones in the center the mass is made more effective. Plants with colored leaves are now extensively used in this way, as the pleasing effect is more permanent. Flowering plants that have to be renewed every year require more attention than shrubs, and do not have the same lasting qualities.

Shrubbery may be made useful in screening objects that are uninteresting, and beautiful in its variety of color and form.

Great advance has been made in the cultivations of shrubs for ornamental planting: the number of hardy varieties is steadily increasing, and the interest taken in them is growing. Large masses of the same variety are now used to heighten the effect at certain points; the choice specimen is given prominence, more room is allowed for free growth, the pruning is done with more care, and the whole effect is one of great richness in materials and growth.

Plantations of shrubs are used to bring buildings into closer relation to the surroundings; they help to connect the lawn with the larger growing trees and rocks; on the margin of pool, lake, or stream they are especially beautiful, as the effect is often doubled by the reflection in the water.

Ivy and the American ampelopis give a most beautiful effect by carrying the green of the foundation of grass up through the more or less rugged foundation of rough stone to the chiseled base.

Trees, both for shade and to add beauty to the landscape, are of the greatest importance. They represent years of growth, and live even in our city streets: they are the crown on the hill, the companion of road, walk, and building, and the clothing of the hillside and hollow. They are of great variety, the pines and hemlocks, with their deep green needles, affording a noble contrast to the light green leaves of the birch and poplar.

The willows by the spring or brook tell of the cool water to all: the maples, with their scarlet buds in spring and yellow and red leaves in autumn, lend a brightness and vividness to the landscape, and are among the most useful of the shade trees.

Brooks, waterfalls, ponds, lakes, rivers, and the shore of the sea, appeal to man in their different ways of adding beauty to the scene he looks at; and, when nature has failed in supplying the first four of these, he can often add the lacking elements.

Let us hope that the demand for parks, gardens, and the preservation of natural features of beauty will grow, and that the supplying of these wants will be entrusted to men especially interested in the throughly artistic development of all the various opportunities in a business-like and sensible way; thus the best results will be obtained from the expenditure, and stupid mistakes will be avoided.

MODERN MACHINE-SHOP ECONOMICS.

By Horace L. Arnold.

VI. FIRST PRINCIPLES IN THE MANAGEMENT OF MEN.

FROM the earliest days of history to the present moment some men have been employers, and other men have been wage-earners; a few have directed the labor of the many, and gathered and accumulated the surplus goods arising from labor, seldom to the entire satisfaction of either party to the transaction of hiring and serving, more seldom to that of both, and not infrequently to the dissatisfaction of both master and man to the bitter extremity of death.

At this moment the labor trouble at the Brown Hoisting and Conveying Works in Cleveland, having already cost several lives and a large amount of money, is being held in check by military force; something like twelve thousand of the united garment workers go on their annual strike; and the largest remaining body of the Knights of Labor, the Pittsburg glassworkers, has just formally withdrawn from that organization, which, had it from the first been under wise and far-seeing direction, perhaps would have become the controlling factor in American politics.

It is absolutely certain that the best policy of neither labor or capital is universally understood; else the history of to-day could not be written as it is. It is not for the mere whim of idle caprice that men change in one instant from sober, industrious, self-denying, and self-respecting workers into a raging mob, reckless alike of their own lives and the lives of others. It is not without motive that artificers, even of the low type of the Jewish tailors inhabiting the east side of New York, voluntarily assume a condition of temporary beggary, abandon their only source of gain,—the sale of their labor,—and enter upon a struggle against their employers and starvation leagued together against them.

Yet there are masters and men, large employers with hundreds of wage-earners, small employers with only tens or scores of workmen, who have never had the slightest unpleasantness in their mutual efforts, which result in at least such benefits to all concerned as make both parties to their unformulated contract of such value to each other that neither wishes to hazard the chances of change.

Since master and man can in these occasional cases sustain their working relations with mutual peace and prosperity, why can not their fortunate condition become the rule instead of the rare exception?

It is most pitiful that a man should expend his whole life in honest, uncomplaining toil for no gain, for no certainty of so much as food to satisfy his hunger, much less of any future state of ease and comfort in accordance with even the humblest desires.

Labor is the only source of wealth. Wealth is merely accumulated labor, has all the rights and producing-powers of labor, and is, perhaps, better defined as "concrete labor" or "permanent labor" than by any other combination of two words.

There is but one single difference between labor and capital considered as commodities: labor must be sold day by day, while capital can wait for a purchaser. If capital is idle, it does not earn, but the capital itself remains, and can wait. The capital of a wage-earner is his power of working, and he must sell his work from instant to instant; otherwise, it is irretrievably and forever lost to himself and to mankind at large.

Accepting these assertions, which are obviously incontrovertible, it is seen at once that the wage-earner at, say, twenty-one years of age, having, say, the trade of a machinist, owner of himself, with a potentiality of earnings beyond the expenditures required to keep him alive and in working condition, has a certain cash value. One man may die at any moment; not so with the body of day-workers at large; each has a certain expectation of life, and consequently an ascertainable present cash value attaches to each individual. So much is certain.

Shall the machinist be regarded solely in this commercial aspect, as a part of the machine-shop equipment, having certain earning potentialities, giving the reasonable expectation of profits to his employer, a means to an end, in a word simply a tool, to be hired at the lowest possible rate, and discarded promptly upon evidence of reduced efficiency?

Probably the truest kindness and charity and philanthropy will answer this question in the affirmative, with only circumstantial qualifications, which do not in the slightest degree modify the policy.

While the workman is, commercially, a tool, he is also a living animal, and must have a suitable vital environment to make his greatest earning.

This living tool has also the power of thought, which leads to content or discontent from either real or fancied causes and again the greatest earning of this living, thinking tool can be made only when his mind is at ease.

The mental ease of the workman may be secured in two entirely different ways.

He may enter a service where the expectation of his earnings is made the basis of a time-continuance element of his pay; he may be insured against want or sudden disaster by accident or sickness from the day he goes to work; he may have his life insured by his employment, so that he is certain of a provision for his family in case of his own death; he may be made certain of continued pay in case of disability through sickness or accident, this payment becoming greater with each added year of service; and finally he may have the certainty of retirement on full pay, at an age which still leaves the expectation of some years of enjoyable idleness at the end of his honorable period of respected and self-respecting toil. This is no dream. It is the policy at Dolgeville, not of a machine shop, but of a manufacturing establishment, in no way differing in its labor employment from a machine shop.

Or the workman may enter service where he is made to feel that he is watched over and cared for individually; that the management is his individual friend; that he is to be pushed to his utmost earning capacity and paid in accordance to his production; that discharge can come only from an intentional fault of his own; and that in sickness, suffering, and death he and his will be assisted and comforted—to what extent? That is a question which cannot be answered in exact terms under the paternal policy of dealing with workmen which obtains in the Baldwin Locomotive works, where there has never been a strike, and where men drive themselves to their utmost production.

Of the two methods that which deals with the worker as a simple tool, a mere commmercial commodity, is undoubtedly in every way the better. The conditions and the rewards are fixed, certain, just, and satisfactory, and they are founded, not on fear or favor, but on a correct basis of money values by which the capital of the master joins with the capital of the workmen in the form of their own bodies, to produce an earned increment of wealth, which is continually divided among all, in sufficient accordance with the needs of each.

If any machine-shop owner wishes to reach this ideal condition of absolutely harmonious effort, he must himself, by his own business foresight, inaugurate such a policy as will result in the Dolgeville or Baldwin or Midvale unity of effort.

The typical wage-earner is, first of all, incapable of managing any business, even his own,—much more that of an assemblage of his fellows. Many large employers have, indeed, come out of the workshop, but they came out early in life; they were never "union" or "trade-society" men; they never affiliated with the herd of wage-earners. Cradled in poverty, they yet had business instincts from the first, which no life-long wage-worker ever has.

It is this lack of business and money-handling and managing capacity which makes all "labor movements" certain failures from the moment of their inception to the infallible disaster of their certain dissolution.

If a man is capable of managing, servitude is revolting to him, and he will not continue a day-wage earner.

But every and any business manager who employs wage-earners can, if he chooses, places his labor on such a commercial footing that no man can leave his service or question his wishes without a prospect of pecuniary loss which the day-worker is not willing to face.

The employer desires the greatest output for the least wages; the workman desires the greatest day-pay obtainable; the employer does not care whether the day wage rate is lower or higher,—he simply desires the largest obtainable profit at the end of each individual transaction. To satisfy the man there must be an increase of wages; to satisfy the master there must be an increase of profit; hence, to satisfy both master and man, there must be an increase of output per hour of labor, because nothing else can give the workman higher day-pay and at the same time increase the profits of the employer.

The fixed charges, interest and depreciation of plant, office expenses, advertising, trade-soliciting, and insurance vary but slightly as the volume of business varies. Output and profits may double in volume with a very small or no increase of fixed charges.

It is in the labor-cost that the manager must find the variable which alone can favorably affect his balance-sheet.

The superintendent, himself a product of the workshop, and knowing perfectly well what the worker can do, stops before a machine-tool which is not removing more than one half the metal per minute which might well and easily be removed; he says nothing, and the workman says nothing, yet each is perfectly aware of what passes in the mind of the other. Continuing his inspection, the superintendent pauses before a vise or floor-hand, with the same silent observation and result. If the superintendent speaks to the workman, he makes a mere casual remark, which the workman returns with deferential good feeling.

It is "a fair day's work for a fair day's pay, and nothing to say."

Yet the cost of the work must be lessened, or the work must stop; either there is no profit, or competition forces a lower selling price. The workman will not exert himself; his output is up to the average of that shop; he is punctual, sober, orderly, civil, and a good craftsman, and is secure in his place because he and his fellows stand shoulder to shoulder, doing so much and no more. If the superintendent demands a greater output, the man seems to exert himself to meet the requirement, but the result is the same in work finished, and the seed of shop trouble is sown. But the superintendent does not commit the folly of demanding more output without increased pay. He offers the workman a piece-rate which will require a slightly increased production to bring the workman his day-rate of pay. The workman slightly exceeds the difference, and adds a dollar or two to his week's wages. The superintendent encourages him, and the next week he does better still, draws still more money, and again has good words given him. The workman now begins to really exert himself; he takes heavier cuts, he thinks, he devises new expedients, new methods, and, if still encouraged, will, in a month or two, be drawing perhaps double his previous pay, and yet leave the shop gainer as well as himself. Other hands become aware of the fatness of this pieceworker's pay-envelope, and respectfully solicit the change to piecework in their own behalf: the system of piece-prices becomes general in the shop, with the result of more and better output at a lessened piece-cost and a greatly increased wage-rate to the men. Then the management says to the superintendent: "You have only average men, yet you are paying about double average wages; you must change this." A general cut is made in the piece-prices, and the men may again increase their pay, and again have the rates cut, or they may be wise, foresee the certain conclusion of the matter, and stop at a very slight increase of production, which will give them at piece-prices a day-pay rate only a small safe margin above the open market-rate of their labor.

This is the inevitable and unvarying result of a fixed piece-rate, precisely the same as a fixed day-wage leads to the "fair day's work for a fair day's pay"; and this is generally regarded by both masters and men as the inevitable finality of the piece-price system, and is the ultimate result if the workmen are considered, not as individuals, but as a class.

The superintendent is perfectly aware that some of his men could largely increase their daily out-put, and he introduces the variable piece-rate; if the production reaches, say, 10 pieces per day, the piece price is to be, say, 35c; if below 10 pieces per day, the price paid is only 25c per piece. This has the effect of stimulating the workman to produce 10 or more pieces per day, if it is possible for him to do so, provided he feels sure that the piece-rate is not to be cut.

In case the piece price is based on a high efficiency of the best tools obtainable, this individualizing of the workmen by the expedient of an unchanging "differential" piece-price is a perfectly safe operation commercially, as it secures the lowest possible piece-cost of output, and at the same time permits the workman to earn more than the prevailing rates of day-pay in the open market. The employer, therefore, is able to compete with any selling rates which can be offered by others, and the workman is obtaining more for his labor than he could obtain elsewhere, and feels that he is his own master, the arrangement resulting in that harmony of effort of master and man which alone can lead to permanence of best obtainable results.

Nothing can be permanent which does not in itself contain the elements of commercial stability. Whatever does not pay its own way must sooner or later cease to exist.

Harmony between master and man must include business success, and permanent business success can be certainly relied upon only when the lowest piece-price production is joined with the highest day-pay rate which the workman can obtain anywhere.

The day-rate of the laborer is less than the day-rate of the trained machinist, yet the specialized laborer's production on a single class of work may, and often does, fully equal, in both quality and quantity, that of the most skilful mechanic. A consideration of this fact opens up a line of inquiry ending in a question as to the need of using machinists to build machines.

Machine shops have been and are operated on the theory that their object is to build machines. In this art view of the case the use of machinists, thoroughly trained and capable of a far wider range of effort than the narrow round of shop routine demands, should constitute the principal part at least of machine-shop labor equipment. But the ultimate object of operating a machine shop is, not to make machines, but to sell machines for more money than they cost. In this commercial view of the case it appears that the ultimate object of the machine-shop is not to make machines, but to make money, and it becomes evident that the trained mechanic need not of necessity have any part in the management of the shop, and it becomes pertinent to enquire whether it is best to have a mechanic anywhere near the management. The commercial instinct and the mechanical instinct are very rarely united in the same individual, and the largest and most successful machine-making establishments in this country to-day are controlled by non-mechanical managers who succeed because they are judges of what will sell, and can foresee the probabilities of future demand.

Viewing men as tools, every added unused power or ability is a detriment.

Ingeniously complicated tools have been devised and built which combined the powers of the lathe and planer, the slotter and driller, or the planer and milling machine, but they are of use only to the smallest jobbing-shop and the amateur; the superintendent of a large establishment would not consider them for an instant as possibly valuable additions to his plant. Why, then, need the living tools be of diversified powers, when only a single function is to be exercised? It is a common saying that there are no more general machinists created; it is a certainty that a very large part of the machine work of to-day is done and well done by specialized laborers, and in the lighter branches even by women working side by side with men at machines which only a short time since were handled by men exclusively.

It seems, then, that the place of the machinist in the machine shop is not very near the top in rank; nor need anything like a majority of machine builders be trained, all-around mechanics. There must be some machinists; there must be some tool-makers; but there may well be a vast majority of one-operation workers, able to manage a single tool and force its production to the highest limit, but otherwise innocent of technical knowledge or skill.

Such single-effort workers are undoubtedly destined to do by far the greater part of the machine building of the future. The place of women in the machine shop cannot now be foretold. Year by year they take heavier work and fill more varied positions, as in electrical construction and bicycle-part making. All ordinary machine work is perfectly within a woman's physical powers; but it seems now, in view of the results of two generations of women metal workers in some New England districts, wholly undesirable that women should become machinists. Still, as we are not ready to adopt the Chinese plan of drowning girl-babies, and workingmen of the machinist grade show a continually diminishing willingness to marry, perhaps the superfluous woman can do worse than enter the machine shop. Where she has entered the shop, she has made the shop better in appearance, though at what sacrifice to herself can not yet be said.

In completing these unfilled outlines of what I believe to be the true economics of the most important present engine of human advance toward better living, the machine shop, I feel that I should use my final words in urging a serious consideration of the methods of dealing with labor adopted by the Baldwin Locomotive works and the Midvale Steel works, or, better still, the absolute despotism of Dolgeville.

I speak from experience on the workman's side of the matter. Day labor is slavery, pure and simple; endurable only because it is voluntary, permitting the slave to select his master. Work for wages merely is vile, and vilely degrades the worker. Every strike—senseless folly as the strike has always proved—is a revolt of manhood against the degradation of unquestioning abandonment of self to another's rule.

At the outset of my twelve years of life as a journeyman machinist

I learned the immortality of time by finding that, in trying to "kill the day," I unendurably increased its seeming length to myself, while, by trying to "kill the work," the day passed so swiftly that six o'clock came as a regretful surprise, too quickly because it left my self-alloted task incomplete. I drew the highest pay; I had the friendship of my employers; every day was full of interesting lessons to me: and I think now, looking back thirty years, that the easiest money I ever earned was earned at day wages in the machine shop. But I saw my shop-mates, lacking my perpetual delight in mechanical operations, some sullen, defiant, jealous, desperate under the double-thonged lash of restraint and their own necessities; others careless alike of themselves and life, wearing the slow hours of daylight away without a thought or an ambition beyond the drinking places in which they passed so much of their nights as their need of sleep permitted; always in debt and always, when perfectly sober, wholly at war with themselves and their own lives.

To-day there is in free, happy America the dogged endurance of the bayonet at Cleveland, the sullen ending in failure of the costly Knights of Labor experiment of the glassworkers at Pittsburg, and the noisy jargon of the Hebrew garment workers as they talk themselves into the frenzy needed to sustain them through the weeks of starving in which they must fight, as best they know how, their ignorant battle against the reducing of their wages.

Let machine-shop owners read Taylor's exposition of the Midvale differential piece-rate system; let them examine the workings of the same system with the "human interest" addition at the Baldwin Locomotive works: and let them be made familiar with the benevolent despotism of Dolgeville.

Let them regard the workman as what he is,—a tool,—and regulate his price by his out-put; let them add to this, if they like, the silvern speech of words fitly spoken. as at the Baldwin shops, or, best of all, to my thinking, let them adopt the golden silence of the ledger and the cash-box. as at Dolgeville, and so make an end to that war of self on self, the "conflict of capital and labor," which is now the bitter disgrace of civilization in its highest form.

Underlying the whole vast fabric of trade and commerce is the machine shop, sustaining all, and making all possible.

Let the easy and profitable methods by which labor is made contented and enjoyable at the Midvale, Baldwin, or Dolge establishments become common in the machine shops of America, and those methods will spread the world over, carrying with them the true liberty which is to be found only in the power of the wage-earner to secure happiness by his own efforts.

THE MANUFACTURE AND USE OF BRICK FOR STREET-PAVING.

By H. K. Landis.

IT is difficult to determine the exact time when brick was first used for street-paving. In a limited way it was undoubtedly employed in ancient times, but it was not much more than a century ago when the Dutch began the development of a brick-paving industry which now has attained considerable magnitude, especially along the River Yssel. The Japanese employed this material about the same time, and the English more than half a century later. In the United States, however, we find no brick-paved streets before 1870, at which date a small section of street was paved at Charleston, W. Va., the pavement being relaid in 1873. Though this brick is simply a hard-burned common variety laid on a board foundation, after twenty-three years in use it shows but one-fourth inch average wear. The example set by Charleston was followed in 1875 by Bloomington, Ill.; in 1880, by St. Louis; and in 1885, by several Ohio towns.

The real beginning of the industry was in 1885, since which it has so increased that brick paving is now used in over three hundred cities of the United States. The older bricks were made from glacial and other silicious clays, including fire clay, none of which will now satisfy the rigorous requirements of construction engineers, although brick is even now made from fire-clays in West Virginia and Tennessee; the high temperature and frequent checking or cracking in the latter, however, are serious drawbacks in manufacture. The principal material used in the manufacture of vitrified brick is a rather soft shale containing about 56 per cent. of silica and 13 per cent. of fluxing constituents.

Making the Brick. This shale occurs near the surface, and is mined by stripping the soil from above the deposit and excavating, either by hand-labor aided by blasting, or by means of a steam shovel. The latter method is the more economical when the capacity of the works is sufficient to keep the shovel busy the entire time. The fire-clays are procured from beneath the surface by the usual pillar and room system of mining used with coal, the pillars being taken out subsequently.

Grinding. After the shale has been placed in cars and carried to the works, it is ground in a chaser, two chasers being required for each brick machine. The chaser consists of a stationary pan about nine feet in diameter, having two discs with a twelve-inch face and weighing nearly three tons each, which chase each other round the annular bottom of the pan, crushing the shale beneath them, which passes through slits in the bottom, when sufficiently fine.

Screening. The ground material from the pans is not uniform in fineness, and must be sifted. Therefore it is run over shaking screens or through revolving cylindrical screens. Fineness is an important element, as the finer clay produces the stronger brick ; moreover, screening increases the capacity of the chasers.

Tempering. This should be thorough, in order to make a homogeneous mixture without any air spaces. Fire-brick manufacturers accomplish this mixing in a chaser or Chilian mill, but, as that is rather slow, the paving-brick makers use a pugmill about nine feet long, having inclined knives set into a central shaft which mixes the material and pushes it to the other end of the cylinder.

Molding. Brick machines are of two types,—"end cut" and "side cut." In both the material is forced through a die, which, in the former, is the shape of the smaller cross-section of a brick : in the latter, the size of a longitudinal section of a brick stood on edge. This process produces bars of clay, which are taken by a continuous belt to a wire cutting-off attachment, where they are cut to the proper length or the desired thickness. The clay from the pug-mill is forced through these dies by screw knives set in a horizontal shaft, or by means of intermittent plungers, the former being the better.

Repressing. Though the rough surface and sharp edges left by the cutting wire on the brick have been accepted by consumers, there is now a growing demand for a nicely-finished article with rounded edges. This has made pressing in properly-shaped dies necessary, producing at the same time a brick which is slightly more dense and somewhat less liable to be laminated.

Drying. After being molded or repressed, the brick are dried in tunnel-driers, into which they are run while stacked in a checker-work on cars. Too rapid drying may cause cracks, while slow drying decreases the output ; between the two extremes there is a happy mean, the exact location of which is often too carelessly determined.

Burning. The best brick are made in kilns where the heated air is drawn downward through the brick by a stack outside, thus insuring an even distribution of heat, regulated by the firing and the damper. These down-draft kilns are of two types ; in the east the round beehive kiln is used, while along the Mississippi the square kiln of three times the capacity is preferred. Great care must be exercised in the burning, as even then the average percentage of good pavers obtained is but seventy. Too high a heat will soften and thus dent the brick; they are too soft, if not burned sufficiently; when cooled too quickly, they check or crack, and become brittle, while slow cooling will anneal them, producing a very desirable toughness. When burned, the brick should be a brownish red; a lighter color indicates too much lime in a shale brick, though it is characteristic of fire-clay pavers. In any case they are burned until a partial fluxing takes place.

Properties and tests. For street-paving purposes brick must be high grade, the principal qualifications being toughness in resisting wear and impermeability in preventing the absorption of water, which might freeze in the brick and thus disintegrate it. There are other qualifications, however, that enter into specifications.

Structure. Laminations may occur in a brick, when it is not thoroughly pugged; with end-cut brick these are concentric and paralleled with the larger axis, while with side-cut brick they run in the direction of traffic, making the brick less liable to chip from contact with horses' hoofs. The worst feature, however, is the cracking or peeling-off upon freezing. In general, such brick must not be used.

Density. The specific gravity will average 2.30 in shale brick, though it may vary two-tenths either way. As these brick absorb about one per cent. of their weight of water, density and porosity are practically identical in showing permeability. Hardness is another relative test; it ranges between 6.5 and 7. on the mineralogist's scale of 1 to 10.

Compression. Where the traffic is heavy and the filling between bricks is sand alone, this is an important factor. Tests show an average ultimate strength of about 15,000 pounds per square inch for shale pavers, and 10,000 for fire-clay brick. There is, however, a wide range, due partly to the difficulty in making the test properly. and partly to improperly-selected material.

Breaking. Should the foundation of a pavement be insecure, a brick may have no support under the middle; hence was devised the test called cross-breaking strength, or modulus of rupture, in which the brick is supported on two rounded wedges six inches apart, pressure being applied on the center. The breaking stress is found to be about 25,000 pounds per square inch of section.

Abrasion. The ability of a brick which has been laid in an unyielding foundation to resist wear is well brought out in this test. A strong cylinder is hung on trunnions and filled to one-fifth its capacity with brick, among them the ones to be tested; the dimensions of this rattler are usually two feet in diameter and three feet in length, though these vary somewhat. A report to the National Association of

Fire-Brick Manufacturers by Prof. Edward Orton* upon standard tests shows (1) that the loss in a rattler is nearly uniform where the brick occupy but 10 to 25 per cent. of the volume; (2) that the abrasion is greatest in the first ten minutes, due principally to chipping, the per cent. loss decreasing at each subsequent period, and the usual practice being to continue the test for one hour; (3) that above twelve inches the length of rattler has no influence on the result; (4) that "the loss varies with the number of revolutions much more than with the time of revolution" (the commission have not yet decided on the proper number of revolutions); (5) that from 26 inches in diameter of rattler upward, the loss in abrasion is nearly uniform, but below that, the loss decreases with the diameter. It was found that cast iron in the rattler gave unsatisfactory results, and that standard brick were preferable to fill up with. Bricks usually lose about 10 per cent. of their weight, and granite 4 per cent., in this test. Square-cornered brick show a greater loss than those with edges rounded in manufacture.

Having tested a number of brick with varying results, making it difficult to determine which is the better, the problem is to give each test its proper weight, so that the tests collectively can be compared. Prof. H. A. Wheeler † has devised the following formula for this purpose, in which the rating for an average paving-brick will be 100.

$$V = 5(18 - R) + 2(7 - A) + \frac{T}{220} + \frac{C}{1000} + \frac{10}{3.25 - D} + \frac{10}{7.5 - H}$$

V = an arbitrary comparative rating.
R = rattler loss in percentage of weight of brick.
A = absorption in " " total " " "
C = crushing strength per square inch.
T = modulus of rupture per square inch.
D = specific gravity.
H = hardness by Moh's mineralogist's scale.

The mean of a large number of tests gives as an average for the above:

R = 8.0 per cent.	C = 10,000 pounds.
A = 2.0 " "	D = 2.25.
T = 2,200 pounds.	H = 6.5.

which, substituted in the formula given, will make V = 100. Very good bricks should range above this. From this it will be seen that the rattler test is given an importance equal to all the others combined, which is as it should be.

* *Clay*, January, 1896.
† "Vitrified Paving Brick," T. A. Randall & Co., Publishers, Indianapolis.

Size of brick. This is a point on which engineers disagree, although most of the manufacturers agree on the standard building-brick size, 8½ × 2½ × 4 inches; for then underburned or rejected brick can be sold for building purposes, thus preventing loss and permitting a lower price on No. 1 pavers. A block 4 × 3 × 9 can not be burned as successfully as a smaller brick, and will not vitrify so thoroughly, though some claim that it is cheaper to lay. A number of patents have been issued on grooves and other devices in the sides of brick, designed to hold the cement and asphalt filling between bricks, so as to prevent loosening. Such devices are of doubtful utility, and, like salt glazing, may cover a multitude of evils under a single advantage.

Construction of street pavements. If a macadam road is to be replaced by brick paving, the macadamizing is first removed, screened, and sifted, as some of the stone can be used in the concrete or in back filling, and the road is then excavated to very near the depth required by t. e grade stakes. The earth is then surface finished by hand and rolled with a steam roller weighing not less than six tons, until compact. Beginning at this point, practice differs. Some will have two inches of sand to drain off the water, covered by six inches of concrete foundation; some, an eight-inch sand foundation covered by a course of brick laid flat: some, broken stone with or without sand. In any case such foundations are wetted and thoroughly compacted by the steam roller. The best and most popular foundation, however, is concrete four to eight inches thick, mixed dry and thoroughly hand-rammed in place. In some cases, to prevent serious freezing, subdrainage is secured by means of drain tile sunk in the soil under the foundation and beside the curb on either side. This precaution would seem unnecessary, did not experience prove its value. The foundation must be made with particular care: if of concrete, it should not be laid in freezing weather, nor should the brick be laid upon it in cold weather without proper provisions for expansion. The binding which will otherwise result as the pavement expands will cause it to rumble, as if it were hollow, when wagons run over it, or may even force up considerable sections of the brick, such being the annoying experience of several cities. It is important that the underside be well drained to prevent local softening of the soil, and also the freezing of water, which may raise the foundation and result eventually in serious cracks. On the surface of this concrete is placed a cushion of dry lake sand from one to two inches thick, the surface of which should be shaped perfectly true to grade and section, as the brick will lie directly upon it. The vitrified brick are then laid with their length at right angles to the centre line of the street,—except at street intersections, where the angle is forty-five degrees,—and are kept in perfect line and level with adjacent brick. They are laid so that the bricks on successive courses break joints at least one-third their length, and are then rammed with a 75-pound rammer, or rolled with five-ton roller. The joints between bricks are filled in with sand, a mixture of asphalt, or concrete, the last being preferable. The sand is brushed in, and a thick layer of sand remains on the bricks to fill such voids as may occur. Asphalt, when preferred, is poured at 300° into the joints until they are entirely full, avoiding any excess. As the cement grouting settles into the joints, it is followed by more, and, when the joints are full, sand is sprinkled over them. This is done to prevent the surface from drying out before it is perfectly set. This top dressing is used in all cases, hot sand being sometimes used with pitch or asphalt. The street is then opened to travel.

Inspection. The inspection of brick is best done at the kilns, but inspection on the ground should never be dispensed with, and everything should be done strictly according to specifications. The engineer should have numerous grade stakes and marks on the curbs for the guidance of the contractor, and should have an assistant, who may also be a constant inspector of the work; for, if doubtful matters are left to the discrimination or judgment of contractors or foremen, the advantage is not likely to be on the side of the city. Specifications, preliminary and final agreements, and contracts should be full, explicit, and in duplicate. The specification and bid should include all details, with the disposition of possible extras included in the specification.

Cost of construction. This item depends upon many conditions, principally freight and character of foundation employed. None but the best obtainable brick should be used in any case. Brick can be bought for $9 per 1,000, unrepressed, or $10.50, repressed at the kilns. Ohio and Illinois are the largest producers of paving-brick. Asphalt is landed from the vessels at New York and Philadelphia. Consequently brick paving costs in St. Louis, per 100 square feet, $14.50 to $15.00, and asphalt $26 to $30,—practically twice as much; while in Brooklyn asphalt pavements are cheaper than brick. Thus we see that the difference lies in freight principally.

General considerations. Wooden blocks laid on end are used where noise is the main thing to be avoided,—as on London streets,—and noiselessness is their only merit. In cost they rank with Telford pavements and brick. Granite blocks and asphalt are usually more expensive, while cobble stone and macadam are less so. According to Prof. Wheeler, the cost of repairs in St. Louis per 100 square feet has been 11 cents for granite, 50 cents for wood and for asphalt, 70 cents to $3.37 for macadam, and as much as $9.40 for limestone macadam. The cost of maintenance of paving-brick construction lies between that of granite and asphalt. An estimate by Rudolph Hering of cost of traction on different pavements is here given :

Comparative Traction with a Given Load.

Iron rails	1	horse.
Street asphalt	1⅔	"
Brick	2¼ to 2¾	"
Granite blocks	3⅓ to 5	"
Wood	5 to 6	"
Good macadam	8	"
Cobble stones	7 to 13	"
Ordinary earth	20	"
Sandy earth	40	"

It will be noticed that brick offers comparatively little resistance. Brick are made with rounded edges at present, to afford a footing for horses, making it available for grades up to 10 per cent. It is not known how long brick will last. The brick first laid are not yet worn out, and they are far inferior in quality to those of present manufacture. Some show a wear of an inch and a half after twenty years in service ; others, but a half inch. Some of the older pavements are being replaced by reason of insufficient foundation and settling, due to the tearing up of the street for pipe-laying, etc. There is no pavement extant which will withstand the pernicious effects of digging up to get at underground pipes. It would be far better, everything considered, to have all underground pipes and wires laid in a conduit large enough to admit a man in addition than to have otherwise good streets converted into a series of mounds and ditches. Back-filling of excavations should always be done with sand or gravel. Brick are kept clean easily, and, with adequate sewers, may be flushed. There are no crevices to fill with decaying matter, and the low absorption (1 per cent.) keeps out all liquids ; so that, outside of asphalt, it is the most sanitary pavement yet devised. Macadam roads must be kept wet in cities to prevent dust, and a little too much water means mud ; flushing with water does not affect brick in any way, especially when the joints are filled with asphalt or cement.

Cities which have used brick paving in the past are now improving their streets with the same material, and no better recommendation can be given it than this practical endorsement.

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Indian Engineering. *w.* 18 Rs. Calcutta.
Industries and Iron. *w.* £1. London.
Inland Architect. *m.* $5. Chicago.
Inventive Age. *s-m.* $1. Washington.
Iron Age, The. *w.* $4.50. New York.
Iron and Coal Trade Review. *w.* 30s. 4*d.* London
Iron & Steel Trades' Journal. *w.* 25s. London
Iron Trade Review. *w.* $3. Cleveland.
Journal Am. Chemical Soc. *m.* $5. Easton.
Jour. Am. Soc. Naval Engineers. *qr.* $5. Wash.
Journal Assoc. Eng. Society. *m.* $3. St. Louis.
Journal of Electricity, The *m.* $1. San Francisco.
Journal Franklin Institute. *m.* $5. Phila
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q.* $2. New London.
Journal Political Economy. *q.* $3. Chicago.
Journal Royal Inst. of Brit. Arch. *s-q.* 6s. London
Journal of the Society of Arts. *w.* London
Journal of the Western Society of Engineers. *b-m.* $2. Chicago.
Locomotive Engineering. *m.* $2. New York
Lord's Magazine. *m.* $1. Boston.
Machinery *m.* $1. New York.
Machinery. *m.* 9s. London.
Manufacturer and Builder. *m.* $1.50. New York.
Manufacturer's Record. *w.* $4. Baltimore
Marine Engineer. *m.* 7s. 6*d.* London
Master Steam Fitter. *m.* $1. Chicago.
McClure's Magazine. *m* $1. New York.
Mechanical World. *w.* 8s. 8*d.* London.
Metal Worker. *w.* $2. New York.
Milling. *m.* $2. Chicago.
Mining, *m* $1. Spokane.
Mining and Sci. Press. *w.* $3. San Francisco
Mining Industry and Review. *w.* $2. Denver
Mining Investor, The. *w.* $4. Colorado Springs.
Mining Journal, The. *w.* £1. 8s. London.
Municipal Engineering. *m.* $2. Indianapolis.
National Builder. *m.* $3. Chicago.
Nature. *w.* $7. London.
New Science Review, The. *qr.* $2. New York.
Nineteenth Century. *m.* $4.50. London
North American Review. *m.* $5. New York
Physical Review, The. *b-m.* $3. New York.
Plumber and Decorator. *m.* 6s. 6*d.* London
Popular Science Monthly. *m.* $5. New York
Power. *m.* $1. New York.
Practical Engineer. *w.* 10s. London.
Proceedings Engineer's Club. *q.* $2. Phila.
Proceedings of Central Railway Club.
Progressive Age. *s-m.* $3. New York.
Progress of the World, The. *m.* $1. N. Y.
Railroad Car Journal. *m.* $1. New York
Railroad Gazette. *w.* $4.20. New York.
Railway Age. *w.* $4. Chicago.
Railway Master Mechanic *m.* $1. Chicago.
Railway Press, The. *m.* 7s. London.
Railway Review. *w.* $4. Chicago.
Railway World. *m.* 5s. London.
Review of Reviews. *m.* $2.50. New York.
Safety Valve. *m.* $1. New York.
Sanitarian. *m.* $4. Brooklyn.
Sanitary Plumber. *s-m.* $2. New York.
Sanitary Record. *m.* 10s. London.
School of Mines Quarterly. $2. New York.
Science *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York
Scientific Am. Supplement. *w.* $5. New York.
Scientific Machinist. *s-m.* $1.50. Cleveland, O.
Scientific Quarterly *q.* $2. Golden, Col
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Journal of Eng. *m.* $2. Ithaca, N. Y.
Southern Architect. *m.* $2. Atlanta
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago
Technograph. *yr.* 50 cts. Urbana, Ill.
Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn
Trans. Assn Civil Engs. of Cornell Univ. Ithaca.
Trans. Am Ins. Electrical Eng. *m.* $5. N. Y.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* $10. New York.
Transport. *w.* £1. 5s. London.
Western Electrician *w.* $3. Chicago.
Western Mining World. *w.* $3. Butte, Mon.
Western Railway Club. Pro. Chicago.
Yale Scientific Monthly, The. *m.* $2.50 New Haven.

ARCHITECTURE & BUILDING

Design, Construction, Materials, Heating, Ventilation, Plumbing, Gas Fitting, Etc.

Houses Built for Show.

About suburban homes clustered around American cities, Mr. R. Clipston Sturgis, in *The Cosmopolitan* for June, expresses the opinion that they lack individuality and seclusion, and that in these respects they present an unfavorable contrast with English suburban residences. *Garden and Forest* (July 8) criticises the *Cosmopolitan* article, basing its criticism not upon any defect of style, or upon any lack of soundness in the opinion expressed, but upon a failure to comprehend the root of the difference pointed out. Mr. Sturgis appears to think the more retired, homelike, and dignified aspect of English suburban and rural houses results from greater attention to their surroundings. The English garden is made the subject of warm praise, and its influence upon home life is presented in attractive form.

Another reason for the more conspicuous character of American rural architecture, deprecated by Mr. Sturgis, he finds in the extensive use of wood as a material for building in the United States. The air of superior permanence and stability which is one of the effects produced upon travellers by English, as contrasted with American, residences seems to this writer unattainable in wood construction. *Garden and Forest* speaks of the prevalence of wood building as compelled by economy, which, as yet, is an American necessity; but it demurs to the general applicability of Mr. Sturgis's proposition, denying that the fault charged can be justly attributed to the majority of American suburban houses, or that, when it exists, as it admittedly does in many cases, its causes are altogether, or even chiefly, such as Mr. Sturgis assigns.

"The main trouble is not with our material, but with the way in which we use it, preferring showiness to quietness, variety to harmony, over-elaboration to simplicity, loudness to modesty, evident costliness to a well-bred reticence.

"But the outer aspect of a house, while it may reveal the owner's character and thus give an insight into his probable habits of life, does not actually mould and determine these habits. They are more directly moulded and determined by the disposition of the interior of his house. It is impossible to lead a comfortable, sensible, profitably-occupied, quietly-amused, genuinely domestic life in a house that has been planned and furnished 'for show.' Many American houses seem to have been built rather as places which may be proudly exhibited to visitors, or in which troops of guests may be sumptuously entertained, than as places in which the occupants, each in his or her individual way, will find the needs and desires of personal existence agreeably and adequately met. They are as well fitted for occupation by one family as by another, and they are not really well fitted for occupation by any family which finds its best pleasures in hours of privacy and domesticity."

But the force of the contrast between the English and American suburban environment is freely admitted.

"The character of the life that is led in a suburban house is determined, at least for seven or eight months in the year, very largely indeed by the character of its grounds. If the grounds are not beautiful, the sense of beauty will be dulled and distorted in those who perpetually gaze upon them. If they are planned for display, as ministers to pride and vanity, the general mental attitude of the family will be unfavorably affected. If they are not well adapted to out-door repose or activity, and to the development of a personal interest in nature and her products, they will not be lived in; the days of the family will be passed indoors, or passed away from home; and the true enjoyments, like the true refining, softening, and cultivating influences of rural or semi-rural life, will be altogether missed. And, if the grounds are adapted to out-door living, they must have a good measure of privacy—of seclusion. The English suburban place, says Mr. Sturgis, 'gives the householder quiet, rest, and retirement.' These are the results of separateness, protection, privacy; and it is their possession which fosters, not only the typical English love of nature, but the typical English form of domestic life,—reserved, intimate, and thoroughly domestic, yet hospitable in the best sense of the word, because the truest hospitality is that which admits the outsider into the most homelike home."

It is noted that the later colonial houses, as a rule, are set nearer the road than are the English, and that their grounds are more frequently at the rear than at the front of the house, while the English practice is the reverse. Privacy of the grounds is secured in the latter case by a wall between the road and the grounds. When the grounds are at the rear, privacy is secured by distance from the road and by the intervention of buildings. But, in considering this point, one recalls many glaring instances where grounds are in the front, and are laid out with the evident intent of affording a good view of the house from the roadway, in order to allow those who pass an opportunity for viewing and commenting upon the style of the occupants. This is the worst possible taste, and amply indicates the love of show which is a common characteristic of those who suddenly acquire the means for display. Such people are comparatively numerous in America, and they are egregious sinners against good taste in other things besides architecture. Refinement of taste appears to be a concomitant of wealth passed from generation to generation, and can hardly be expected to be the rule yet in a country only a little more than a hundred years old, more than half of which has been redeemed from the wilderness state during the last fifty years, which has largely been settled by the lowest classes from foreign lands, and in which sudden acquisition of wealth by the few has been a social phenomenon during the last thirty years. One may acquire dollars rapidly, but good taste is of slow growth. And, in a land of parvenus, is it worth while to quarrel with the very natural desire of the parvenu to announce, in the only way possible to him, his emergence from poverty into wealth? We must wait for art and taste till the parvenu age in social formation is succeeded by the slow deposit of another stratum.

Facts About Plumbing.

THE LANCET (London), having selected a special commission to examine and report upon the relative efficiency and cost of plumber's work, published the report as a supplement to its issue of July 4. The facts that this paper is a medical journal and that the information sought was collected in the interest of sanitary science rather than with a view to benefit the trade of the plumber do not, however, render the report less valuable to architects, builders, and plumbers. On the contrary, it contains much that is of special importance to those engaged in the practice of these arts.

The architect is first mentioned in this report, and the wide range of qualities and qualifications necessary to the successful practice of his honorable profession are named. An architect should have considerable scientific knowledge, be sympathetic that he may readily assimilate the ideas of his clients, and have good administrative capacity. The use of such a man "simply as a taskmaster to wrest and screw work out of the contractor," as the report says is now done, is denounced as "nearly equal to the employment of Michel Angelo in moulding an image of snow."

The report holds that the interests of the architect and the builder, as far as possible, should be one, and not, as is too often the case at present, opposed. If a stranger to the system were to take up an ordinary memorandum of agreement to be signed by the contractor for the execution of some small contract, say for £1,000, the first idea would be one of surprise that a man who required to be so much controlled as this contractor should be employed at all. The contractor is evidently branded as a dangerous rogue, who will try every dodge, even to taking refuge in the bankruptcy court, in order to avoid the proper execution of the work. Nay, more, he must sign away his birthright in many cases, and the architect's or arbitrator's ruling must have the force of a rule of court. Against this somber background the character of the architect, shown in a few light touches, stands out in pleasant relief. In the course of this inquiry it has become apparent that the contractors are themselves much to blame for their anomalous position. In their anxiety to obtain work it is undertaken at prices which would yield no profit if efficiently executed, irrespectively of possible errors in calculation. There is the chance that something may occur to upset the contract, and in that event they may continue the work upon better terms; or, again, they may have a quantity of machinery that would stand idle unless the work were obtained, in which case their loss would be still greater. If a contractor enters upon work upon either of these conditions, the natural tendency is to seek relief by "scamping" it in some form. The effect that this has upon the architect is very marked.

As to the information obtained by architects with reference to prices, it is stated that "this comes to them at second hand," that it is made up from schedules of lowest prices in previous bids for contract work, that it is an average of these prices which forms the standard, and that this standard "cannot be taken as proof of the real cost of work properly carried out." Especially in the case of leasehold property does the system now in vogue have bad influence upon plumbing work. The architect reasons that the work need not be of a very lasting character, so far as his client, the lessee, is concerned, and proposals for the performance of work at "cut" prices (resulting, as a matter of course, in inferior work) are readily entertained. The contractor is cut down in price to the finest possible figure. The master plumber particularly suffers from this, as contractors now either employ men directly, or occasionally sublet to the master plumber the work, while absorbing a part of his profit. The master plumber at one time could rely upon keeping a certain staff of picked men in constant employment. Now the contractor generally discharges the men directly they have completed the work in hand, and with this knowledge much of the interest the men formerly had in their work and their employer ceases. The tendency to cut down prices beyond a certain point leads to bad work. There is a great distinction between healthy and unhealthy competition.

The sum of the conclusions reached appears to be that the art of plumbing has been so greatly advanced that the presence of inferior work in any recent construction is, in all probability, an indication of an effort to cheapen its cost below reasonable limits. This practice has given rise to the unhealthy competition prevailing throughout the trade. Here again the fault is referred back to the architect.

"The architect who is competent to arbitrate upon a builder's account is also competent to say whether an estimate is fair and reasonable without pitting a number of men one against another. Where the architect exercises this power the best work is done, the inducement to scamp work being removed, and that to carry out the work satisfactorily remains, as there is a reasonable hope of future work being obtained from the same architect. If, on the other hand, the architect's client hopes to gain an advantage by the mistakes or necessities of others, the present system of competitive contracting affords him every prospect of attaining that end. Such competition, however, tends more towards a low price than efficiency, the contractor knowing that, no matter how well he may execute the work, it will not insure him other employment from the architect, unless his tender is again the lowest. That the quality of the work suffers is well known, as board schools and other buildings have been erected with drains unconnected with the sewer, or other omissions of an equally injurious character. It is, indeed, to the credit of the professional men who administer such a system that so large a leaven of latent honesty still remains undemoralized in the trade itself."

Finally a remedy is suggested,—to wit, an agreement upon standard prices for plumber's charges, and a properly qualified board of arbitrators to which, at little cost, an appeal may be made by either side. The present status too often creates a sort of duel between the architect and the contractor employed, "the latter endeavoring to make a surreptitious profit by evading or 'scamping' his work, though the same is included in his contract or account. In the end the architect's client often pays a good deal more than ten per cent. profit upon the work actually done, but the quality is inferior, and every person connected with the transaction has been more or less demoralized."

Wind Pressure.

THE ENGINEERING RECORD (June 6) made the St. Louis tornado and its disastrous effects the occasion for again alluding to the meager knowledge of this subject possessed by the engineering and architectural professions. The difficulties that here beset original investigation are admitted and well indicated.

"Long columns, timber beams, and plate girders may easily be tested to destruction, and be made to yield complete data necessary for the best design; but an artificially destructive wind-pressure acting against a building or a bridge is not so easily arranged for, setting aside all questions of cost. The incidental problem of the relation between wind-velocity and pressure is shrouded with almost or quite as much doubt, in spite of the fact that the weather bureau of the United States government uses a table of relations in which the pressures per square foot for stated velocities are given to hundredths of a pound. Incidentally it would be interesting to know how such values have been established in the absence of direct tests.

"The results obtained by Sir Benjamin Baker on his surface of three hundred square feet, at the site of the Forth bridge, as well as on the smaller surfaces he employed, are, of course, well known, and they constitute nearly all the experimental, quantitative data of value which we have; yet their range is not large, and they leave the greater part of the problem unsolved. Indeed, the securing of the desired data in anything like completeness is necessarily a slow process, for the reason that actual winds, as they blow, must be employed. The best and, one might say, the only opportunities offered for these investigations are just such disasters . . . as that which visited St. Louis. This last one was far more destructive than that which passed over the same locality about twenty-five years ago. At that time the wind turned over a locomotive, and Mr. C. Shaler Smith, with the analytic acumen which characterized so much of his work, was quick to use the incident to demonstrate that the pressure acting could not have been less than ninety-three pounds per square foot."

The suggestion is then made that the portions of the timber roadway blown off from the Eads bridge, and the portions of masonry which were blown down, might supply the needed data for the computation of the wind pressures that effected these results, were they treated by the method employed by Mr. Smith in the case of the overturned locomotive. The ability of civil engineers in St. Louis to deal with any such question is complimented, and the suggestions are commended to their careful consideration.

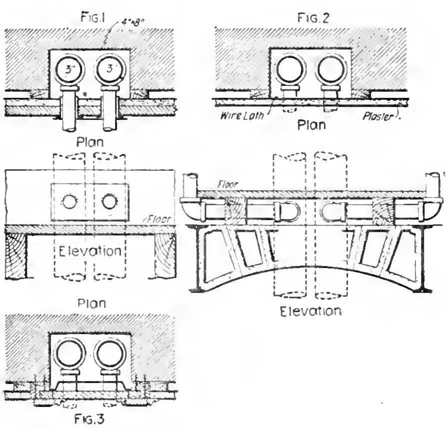
The conclusion of the article voices a feeling of insecurity relating to modern tall buildings, which many have entertained, for the most part, rather vaguely. The great tornado did not exert its full violence on any of this class of structures. None of them lay in the path of its greatest intensity. What might have happened had the same force been exerted upon any of them as upon the bridge is purely a matter of speculation. Evidently *The Engineering Record* thinks there is grave room for doubt that all of them are of a character to withstand such a trial of strength.

"Some high grain elevators and flour mills were destroyed, but no information is given as to their design or construction. The modern tall building has yet to be subjected to these intense wind tests. Where properly designed and constructed, we believe there is little to be apprehended, but destructive wind pressures like those at St. Louis, Louisville, and other places, demonstrate that those who indifferently recognize or, worse, neglect wind effects of high intensity in their designs, invite disaster, and in some cases will probably secure it."

Pipe Chases.

THE illustrations herewith presented of methods of forming pipe chases for heating mains are reproduced from *Engineering News* (July 18).

The illustrations were presented in an answer to a correspondent who wished information upon the methods in use, and also upon means in use for affording access to heating pipes after their erection. The usual size of a chase called for on architects' plans is eight inches in breadth and four inches in depth of the recess. "Figure 1 shows one of the methods of constructing these. The furring strips are nailed to the wall, to which are fastened the wire lath, and on top of this the plast-



ering is laid. The figure shows the section taken through the baseboard. When the piping is carried above the flooring, holes are sometimes cut through the baseboard and plastering, and a metal sleeve, the outer edge of which is flanged, is pushed into the holes. This metallic sleeve is elliptical in section, with its longer axis in a vertical position, to allow the risers to expand. Frequently a sheet of metal, with small holes in which the horizontal branches fit tightly, is placed over the front of these elliptical openings, the metal sheet being of such a size as to entirely cover the elliptical opening, whatever may be the position of the branch in it. Where steel construction with hollow tile or masonry arches is used, the flooring is generally nailed upon sleepers about four inches in height. You have to carry the steam pipes in this space, holes being cut in the sleepers where the pipes pass through them. In both of these instances the pipe chases are not accessible, unless the plastering, wire lath, etc., are removed.

"Figure 3 shows another form of construction. On either side of the pipe chase a wooden 'ground' is nailed to the side wall, and the thickness of the abutting furring strip, wire lath, and plastering is such that the latter will come flush with the outer face of the ground. The ground is recessed so that a panel reaching from the floor to the ceiling may be inserted. Frequently a finish consisting of some appropriate molding is nailed on to the ground, and also to the panel. Against the inner face of the panel a tin back should be nailed to prevent the radiant heat from reaching the wooden panel Frequently, however, a register is placed in the top and bottom of the panel to maintain a circulation of air through the chase. Where this is done, the tin backing is sometimes omitted."

Wired Glass in Fire-Resistant Windows

ONE of the latest materials for building construction is called wired glass, which takes its name from the fact that the panes or sheets are formed upon wire netting imbedded in the body of the glass Some of the usual effects of sudden, or o prolonged, heating, and sudden cooling,—as by water thrown upon hot glass in extinguishing fires in buildings,—are by this means avoided, and the material seems likely to come into extensive use for sky lights, windows of warehouses, and, in short, generally for windows where the outside appearance is of little or no importance, and wherein resistance to fire i of great moment.

The opinion here expressed is based upon some recent tests of the fire-resistant quality of wired glass, made under the supervision of Secretary Charles A. Hexamer, and Inspector William McDevitt of the Philadelphia Fire Underwriters' Association.

In these tests (reported in *Monthly Report of the Boston Mutual Fire Insurance Company* for June) a brick building nine feet high was erected and provided on one side with a pitch roof of wired glass. Side-windows and a glass door, with wooden frames encased in tin, were also placed in the building. Draft holes for free entrance of air were left at the bottom of the building. The structure was filled to the height of six feet with rosin saturated wood. One side of the pitch roof was made of ordinary rough-surfaced glass, such as is commonly used for sky-lights. The roof glass was supported by metallic frames.

Upon firing the wood the ordinary glass broke and fell in five minutes. On the other hand, the wired glass, although the heat was raised to a degree that cracked the brick walls, and charred the tin-covered window frames, retained their integrity throughout the test.

The rationale of the greater resistant power of the wired glass is that, when the glass cracks, as it does at first, the fragments are retained in position by the wire netting, until they fuse and are cemented together again. The fusion of glass occurs at a temperature below that of the fusion of wire, and, the glass being a poor heat conductor, each protects the other.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Architecture and Building and Allied Subjects in the American and English Architectural and Engineering Journals—See Introductory.

Construction and Design.

*7005. Construction in Earthquake Countries. John Milne (The series is based upon building regulations and experiences from nearly every earthquake shaken country in the world, and the study of thousands of ruined buildings in Japan). Engng-July 3 Serial. 1st part. 3400 w.

7019. The Design of Steel-Skeleton Buildings (Some contributions to the history of this construction by architects and engineers who are familiar with the work, called forth by the query of F T. Gates, in regard to the originator of this construction). Eng Rec-July 11. 2000 w.

7021. The Standard Block, New York City (Illustrated description of foundations, plan, location of piers, details of caissons, derrick and general elevation of a building which will be constructed and equipped in conformity with advanced practice for fire proof steel-cage office buildings). Eng Rec-July 11. Serial. 1st part. 1500 w.

7022. The Buffalo, N. Y., Building Ordinance (Extracts from the new building law of named city with adverse editorial criticism). Eng Rec-July 11. 3500 w.

*7025. Should Architectural Competitions Be Abolished or Regulated? (Extracts from papers by Mr. John A. Fox, Mr. R. D. Andrews and Mr. H. Langford Warren, which have the approval of the editor). Brit Arch-July 3. 1500 w.

7026. Self-Helps. C. H. Blackall (A suggestion of ways in which architects may improve constantly in their work). Am Arch-July 11. 2500 w.

7027. Salisbury Close. A. B. Bibb (Illustrated description of the cathedral and houses about the Close). Am Arch-July 11. 1300 w.

7028. The Action of Heat on Cement. J. S. Dobie (A paper read before the Eng. Soc. of School of Prac. Sciences, Toronto, Canada. In the interest of fire-proof protection, showing what may be expected from a mass of concrete or cement when subjected to great heat). Am Arch-July 11. 2300 w.

*7030. Selby Abbey (Illustrated description). Builder-July 4. 2500 w.

*7038. Ecclesiological Notes from North Germany. T. Francis Bumpus (The German pointed architecture as exemplified in the buildings of Westphalia, and the architecture of Belgium and the Rhineland. An account of a trip for study, by the writer. The first part treats of Aix-la-Chapelle and Neuss). Arch, Lond-July 3. Serial. 1st part. 4500 w.

*7072. The Owen Jones Student 1895: His Notes and Impressions in Italy. John J. Joaso (Description of a town containing interesting architectural information). Jour Roy Inst of Brit Arch-June 25. 5000 w.

7155. "Oracle" Cottage Contest (A competition to show what could be done with a limited amount of money. Illustrated description of the first and second prizes of a cottage not to cost over $1250). Arch & Build-July 18. 400 w.

7170. The Château de Blois. W. T. Partridge (A brief history of the château. Part first describes the approach, the façade, the court yard, and the wing of François I). Am Arch-July 18. Serial. 1st part. 2000 w.

*7173. Canterbury Cathedral (From the *Daily Chronicle*. Remarks on the present state of the cathedral of Canterbury. An appeal for needed repairs). Arch, Lond–July 10. 2000 w.

7184. The Era of Better Buildings in New Orleans (The improvement of business buildings in the last few years is briefly noticed, with illustrations of two buildings). Mfrs' Rec–July 17. 1000 w.

7245. Recent Changes in Structural Shapes of Rolled Steel. F. E. Kidder (Table giving the standard weights for beams and channels, and the weights and areas of the standard sizes of angles, as adopted by the Assn. of Am. Steel Mfrs., with additional information). Arch & Build–July 25. 800 w.

7285. Plate-Girder Construction for a Large Church Dome (Illustrated description of the construction of Christ Methodist Church, Pittsburg, Pa.) Eng Rec–July 25. 350 w.

*7312. The Halifax New Infirmary (Illustrated description with information regarding the selection of location, plans and costs). Arch, Lond–July 17. 2500 w.

*7313. The English House (A review of the process of evolution which has produced the house of to-day from the primitive hut of the early Briton). Ill Car & Build–July 17. 3200 w.

7349. Monument Erected on the Kyffhauser in Honor of Emperor William (Illustrated description). Sci Am Sup–Aug. 1. 1000 w.

7350. Græco-Phœnician Architecture in Cyprus (Epitome of a paper read by Dr. Max Ohnefalsch-Richter, before the Royal Inst. of British Architects). Sci Am Sup–Aug. 1. 1300 w.

*7420. Building a Greenhouse (Discusses their need of paint, material for roofs, the roof plate, and the ridge pole). Ill Car & Build–July 24 1300 w.

*7449 "Friedrichshof," near Homburg (Illustrated description of the new home of the Dowager-Empress Frederick of Germany, the Princess Royal of England). Builder–July 25. 2000 w.

7509. Underpinning the Stokes Building, New York City)The problems that arise in the erection of the tall and heavy buildings in lower New York, are considered, and a description of the work named, with illustrations, is given). Eng Rec–Aug. 8. 3800 w.

7510. A High-Duty Pump and Elevator System for a Warehouse (Description of the plant, and of the pump, with the results of its economy test, in the building known as Cupples Station, in St. Louis, Mo. A system of 52 elevators, doing heavy work. The system is worked under a pressure of 750 lbs). Eng Rec–Aug. 8. 1400 w.

*7521. Optical Refinements in Mediæval Architecture. William H. Goodyear (Report of the Brooklyn Institute Survey. The source of the picturesque in mediæval building; cause of inferiority of modern architecture; a study and discussion of the construction, &c). Arch Rec–July-Sept. Serial. 1st part. 5000 w.

*7522. Modern Hospitals in Europe. Alphonse de Calonne (Interesting illustrated description of the architecture, or system of arrangement, in European hospitals, with the improvements introduced in the modern buildings). Arch Rec–July-Sept. 8000 w.

*7523. Dr. William Thornton, Architect. Glenn Brown (An interesting biographical sketch, and the connection of Dr. Thornton with the history of Washington city. His career as an architect and his work, with many illustrations, including his design of the Capitol). Arch Rec–July-Sept. 4800 w.

*7524. Authority in Architectural Design. John Beverley Robinson (The restrictions placed on architects in this country, with causes. The æsthetic sense of the French, and their achievements in architecture; criticism of American architecture, with discussion of best means for correcting its faults). Arch Rec–July-Sept. 3500 w.

*7525. Architectural Aberrations —The Salvation Army Building in New York (Severe criticism of the structure (Arch Rec–July-Sept. 1200 w.

Heating and Ventilation.

7023. Heating and Ventilating of a Bank Building (Illustrated description. Indirect hot-water heating. Forced circulation of air). Eng Rec–July 11. 1100 w.

7104. Ventilation of the National Capitol. J. G. Dudley (An interesting description of plant which was designed by Gen. Meiggs, and has been in operation for more than thirty years). Heat & Ven–July 15. 2000 w.

7109. Heating and Ventilating of the New Masonic Temple at Albany, N. Y. (Illustrated description). Eng Rec–July 18. 800 w.

*7122. Ventilation for Residences (The neglect of architects to consider ventilation in plans for residences is criticised). Dom Engng–July. 900 w.

7414. Combined Warming and Ventilation of Public Buildings. J. D. Sutcliffe (Read before the Manchester Society of Architects. Consists of an introduction and discussion of warming by direct and indirect radiation; three systems of central heating; reasons for adopting the warm air system; warming and ventilation without mechanical power; mechanical ventilation; with description of some installments and practical hints). Arch & Build–Aug. 1. 4800 w.

7418. Heating System in an Extensive Country Residence (Illustrated detailed description). Eng Rec–Aug. 1. 2000 w.

*7439. Ventilation (The statement of requirements is regarded as much more simple than their satisfactory fulfillment. The injurious principles given off in expired air are grouped as carbonic impurities, as distinguished from carbonic acid, which, were it the only impurity, would not generally be present in injurious quantity). Arch, Lond–July 24. 1600 w.

Landscape Gardening.

7076. English Gardens Unsuitable for America (Editorial suggested by articles in *The Cosmopolitan*, by R. Clipston Sturgis, giving reasons why gardens in America must differ from the English) Gar & For–July 15. 2000 w.

7156. Forestry at Biltmore (Some information regarding the methods employed on the estate of George W. Vanderbilt). Arch & Build–July 18. 1000 w.

*7239. Old Time Flower Gardens. Alice Morse Earle (Descriptive of old fashioned gardens, especially those of colonial times, with many beautiful illustrations). Scribner's Mag–Aug. 5000 w.

7314. Delights of a Rough Garden. D. H. R. Goodale (A plea for a garden in which neatness is not the first essential). Gar & For–July 29. 1000 w.

7315. The Hardy Plant Border. Edward F. Canning (Description of plants that do well in this position). Gar & For–July 29. 700 w.

7316. Some Good Annuals. Robert Cameron (Descriptive of numerous flowering plants which may be effectively placed, with suggestions of location). Gar & For–July 29. 1200 w.

7453. Suburban Homes. Sylvester Baxter (An article suggested by the criticisms published in this paper, of a paper by R. Clipston Sturgis, in the *Cosmopolitan*). Gar & For–Aug. 5. 2200 w.

Plumbing and Gas Fitting.

*7174. The "Lancet" Commission on Plumbing (Report dealing with the qualifications of architects; standard of prices, how formed; arbitration; healthy and unhealthy competition; the plumbing expert; question of cost, and plumber's profit and loss account). Arch, Lond –July 10. 2500 w.

7286. Plumbing in the Hotel Jefferson, Richmond, Va. (Illustrated description). Eng Rec–July 25. Serial. 1st part. 1600 w.

7493. Scranton, Pa, Plumbing Ordinance (Complete copy of the new plumbing ordinance proposed at Scranton, which is considered exceptionally well written and deserving of adoption without material alteration). San Plumb–Aug. 1. 3000 w.

Miscellany.

*7016. Practical Sanitary Science. William H. Maxwell (Information of interest connected with ventilation, calculation of areas, water and water supply, plumbing work, removal of refuse, etc. First part treats of ventilation). San Rec–July 3. Serial. 1st part. 2500 w.

*7031. Rural Drainage (The first part is preliminary and discusses definitions, statutes, etc). Builder–July 4. Serial. 1st part. 1300 w.

*7121. Country Houses and the Disposal of Their Sewage (Address by George E. Waring before the Metropolitan Club, New York. Principles governing the work at the present time. A plain, practical treatment of the subject). Dom Engng-July. 3500 w.

*7150. The General Character and Properties of Sandstones. T. C. Hopkins (Descriptive of varieties of sandstone and their uses). Stone–July. 2500 w.

*7171. Tests of Canadian and English Brickwork (Illustrations and some particulars of tests of common brick conducted by C. H. C. Wright and his assistants at the School of Practical Science, Toronto). Can Arch & Builder–July. 1700 w.

*7172. Talks on House Painting (Calls attention to the fact that it pays to have painting done as well as possible). Can Arch & Builder–July. 1800 w.

*7175. A Hausmann for London (From the *Telegraph*. The subject of municipal embellishment. Its financial returns. The beauty of Paris, Berlin, and other cities, and the needs of London). Ill Car & Build–July 10. 1200 w.

†7192. Architecture and Decorative Art at the Art Institute of Chicago. P. B. Wight (Review of the work of the Art Institute of Chicago for the past year and subjects connected). In Arch–July. 2000 w.

†7193. A Rambler (Travels in Baltimore, Washington and along the Potomac, giving impressions of architecture, monuments, etc). In Arch–July. 3800 w.

*7244. Damascus. From *Baltimore Sun* (Its history and architecture). So Arch–July. 2000 w.

*7246. The Preservation of the Coptic Antiquities in Egypt. Somers Clarke (Paper read before the Soc. for the Protection of Ancient Buildings, with discussion. A study of Coptic church architecture). Builder–July 18. 7000 w.

7368. The Legal Duties of Engineers and Architects. Jas. C. Bradford (Condensed from an address delivered before the Engineering Assn. of the South. The importance of the duties and functions of architects and engineers). Eng News-July 30. 2300 w.

†7401. The Fire-Retarding Qualities of Wired-Glass. Charles A. Hexamer (At the request of the Mississippi Glass Co., which controls the manufacture of wired-glass, the writer, in conjunction with Inspector William McDevitt, made a series of tests of the fire-resisting qualities of wired glass. The main test is described in report given. Also report of test made in Boston is given. Illustrations). Jour Fr Inst–Aug. 2200 w.

*7419. The Churches of St. Petersburg (Describes St. Isaac's Cathedral, exterior and interior, and briefly refers to other structures). Ill Car & Build–July 24. 2700 w.

7422. Church Organs and Organ-Cases (Translated by F. G Lippert from a paper prepared by order of the Union of German Church Organ Builders, and publised in the *Deutsch Bau-Zeitung* of Berlin. Injurious practices of architects that injure organs, and calling attention to evils encountered in furnishing organs for new church edifices). Am Arch–Aug. 1. 2500 w.

*7480. Government Tests of Building Material (Report of important tests of building material made at the Watertown Arsenal, Mass., with the two principal objects of ascertaining the strength and acquiring a knowledge of the durability). So Arch–Aug. Serial. 1st part. 1300 w.

7489. Preliminary Report of the Committee on Tests of Fireproofing (Progress made to date in the work of the committee. Gives results of tests of unprotected columns, with illustrations). Eng News–Aug. 6. 2200 w.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

Earthquakes and Engineering Construction.

Mr. John Milne's paper on "Construction in Earthquake Countries," in *Engineering*, affords a striking instance of the success attained, by an intelligent application of scientific methods, in coping with a commonly-considered uncontrollable force of nature. Not that earthquakes have been harnessed or reduced to rule and order, but that much has been done, by a careful study of their phenomena, to determine their more dangerous tendencies, to provide means of lessening the risk by avoiding the conditions proved to be the most destructive, and to reduce largely the risks which must still be met.

It has been found by seismometric observations, and by a careful examination of the results of shocks in earthquake countries, that certain districts of maximum effect can be marked out. The first of these, as stated by Mr. Milne, is that "high, hard ground suffers very much less disturbance than soft, low ground." "Marshy, wet ground, which is popularly supposed to absorb earthquake motion, is notably a bad foundation. Experiments show that, although the period of motion is lengthened on such ground, the advantage thus gained is more than counterbalanced by the enormous increase in amplitude."

This is quite contrary to the usual belief, but is so well recognized that in Tokio the city is clearly divided into two districts, of differing danger, the higher being much the safer; in Manila, special building regulations govern the structures erected on low ground, and in Ischia the erection of dwellings in certain defined areas of loose ground is absolutely prohibited.

A second and more obvious principle is "that all steep slopes covered with alluvium are dangerous," the tendency being, of course, for the loose covering to slide away. "A third class of localities fraught with danger is the upper edges of cliffs, scarps, and natural or artificial open cuttings," because "the materials adjacent to the free face, being unsupported on that side, swing forward beyond the limits of their cohesion, and separate from that which is behind."

Next to the avoidance of situations of especial danger come the provisions for minimizing the risk upon the more slightly affected ground which must be occupied. These naturally relate chiefly to foundation construction. "The Ischian regulations provide that buildings must be founded upon the more solid ground. If, however, the ground is soft, a platform of masonry or cement should be formed" .7 meter thick for a one-story building and 1.2 meters for a two-story building, extending from 1 to 1.5 meters beyond the wall. "In Manila it is stipulated that the foundations must be able to bear at least twice the weight that is to be placed upon them. When the soil is bad, it must be piled, or consolidated by a bed of hydraulic concrete, and the foundation of a building must, as far as possible, be made continuous," the idea being that the "building which stands upon a continuous foundation sufficiently well bound together to move as a whole suffers less racking than if it rose from a base the different parts of which might be simultaneously moved in several different directions." Further, as it is found that the movement in piles 10 to 20 feet deep is less than that upon the neighboring surface, "it may be concluded that a building rising freely from a dry foundation . . . will be subjected to less movement than one rising directly from the surface." This is, indeed, exemplified by certain of the Imperial University buildings in Tokio.

Quite the opposite of these means is the next suggestion of minimizing the motion by giving a building free foundation,—that is, resting pier foundations on plates carried in turn on cast-iron shot, or short rollers placed at right angles, trusting to the inertia of the building to maintain it at rest while the ground beneath moves rapidly to and fro. This, however, although it has given satisfaction in certain cases, is suggested by Mr. Milne as probably applicable only to small, light structures; it is, moreover, "ineffective in resisting vertical displacements, or the effects of rolling which accompanies strong undulatory motion." It would not seem adaptable to any heavy engineering construction, which must depend on depth and strength of foundation and, possibly, elasticity of superstructure.

The New Tehuantepec Railway Concessions.

THE importance of the interoceanic route across the southern border of Mexico, from the Gulf of Campeachy to the Gulf of Tehuantepec, which was so effectively treated by Mr. E. L. Corthell in THE ENGINEERING MAGAZINE some time since, is recalled by the notice given in *The Indian and Eastern Engineer* to the new activity infused into the enterprise by recent action of the Mexican government.

Messrs. S. Pearson and Sons, according to this report, "have secured a lease of the Tehuantepec railway" and "entered into an obligation that is huge even in these days of gigantic undertakings." The undertaking is not clearly defined in the report, but is understood to involve ballasting the line, replacing timber bridges and culverts with iron and masonry, creating an artificial port at Salina Cruz on the Pacific side, and improving the harbor of Coatzacoalcos on the Gulf of Mexico. The harbors alone are expected to cost about $10,000,000,—a large increase over the estimates for Mr. Corthell's project in 1894, which contemplated the expenditure of less than $6,000,000 on the harbors and only $8,000,000 for the entire work, including the completion, improvement, and equipment of 190 miles of railway.

The work mapped out, however, appears to be much the same, and consists principally of dredging the bar and constructing jetties to maintain the channel on the Gulf side, and building a breakwater and deepening the area within it on the Pacific coast.

The writer in *The Indian and Eastern Engineer* (who acknowledges, in a general way, indebtedness to Mr. Corthell for information) reminds his readers that the new route will reduce the time of a sea trip from New York to San Francisco to twenty days, and from San Francisco to Liverpool to twenty-nine days, and predicts an "influence on British trade which it is impossible to overestimate," though the reason for the national limitation is not evident, and the case is better stated in the preceding broad proposition that the enterprise is "international in its scope and of the greatest importance to the development of the commerce of the world"—perhaps "destined, so far as the Mexican isthmus is concerned, to solve the problem of communication between the Atlantic and the Pacific coasts."

"French corruption, on the one hand, and American incapacity, on the other," are unkindly coupled as causes rendering "impossible, for the present at all events, the construction of either the Panama or the Nicaragua canals, and thus it happens that this railway has been left to provide for the great and growing requirements of the traffic between the west and the east."

"Has been," however, is a little premature; the completion has not yet gone into the past tense, and a singular series of failures attended the former efforts. The first concession—to Edw. Learned in 1878—was terminated when only thirty-five kilometers of railway had been built. Several successive private ventures failed; so did the contract with Delphin Sanchez. The next contract,—with Edward McMurdo of London,—involving only the railway without the terminal works, was not carried out, "partly through the death of the concessionaire and partly through other causes." What remained of the fund obtained from the bonds issued for the McMurdo contract was given to a firm made up of Messrs. Stanhope, Hampson, and Corthell, to prosecute the work; finally, the junction of the two ends still being uneffected, another contract was made with Mr.

Stanhope, and the line completed in somewhat temporary form in 1894.

It took another million dollars in gold and upwards of two and a half millions in Mexican silver (in addition to the million and a quarter of silver and over four million pounds sterling in gold already expended) to provide, under contract with Messrs. Hermances, "equipment and some permanent structures;" and still "ballasting has yet to be done, and the timber bridges replaced by iron and masonry."

The greatest credit belongs to President Diaz for his faith in the enterprise and his boundless perseverance through so many disappointments. It is much to be hoped that the present contracts, under which work is said to be making "really splendid progress," will indeed complete the entire project.

Bridging the Mississippi at New Orleans.

THE importance of the Tehuantepec trans-isthmian route to American commerce was fully recognized by Capt. Eads: "We must next discharge the commercial volume of the Mississippi into the Pacific ocean," he said, the "next" being subsequent to his magnificent success in making the lower Mississippi an open highway for cargo-carriers of all classes. How far the creation of this great thoroughfare of trade has resulted in a conveyance of traffic lines at its portal is well set forth in the *Manufacturers' Record* in its New Orleans supplement.

In 1876 the total tonnage entering the port of New Orleans was 1,908,114; in 1892-1893 (the latest date of detailed information) it was 3,333,658, and by far the greatest increase was in the largest class of vessels.

The attendant growth of railroad traffic, related to the receipt and reloading of this freight, has swelled the number of cars handled at the city from 151,332 in 1880 to nearly 550,000 at the present time, and has converted New Orleans into a center concerning which Mr. E. T. Jeffrey of the Illinois Central said a few years since: "no other city of the world—and this may seem like a broad assertion—through its systems of railway covers so directly and without the use of systems reaching rival cities so vast an area of productive territory."

The free and advantageous movement of this traffic about the city brings its own problems, and the very waterway which focusses the radiating lines becomes itself an obstacle to rapid interchange of railroad freight. To remove this difficulty, a bridge is projected to cross the river about four miles above the city; the charter was obtained in 1888, the site carefully selected, the plans approved by the secretary of war, all details worked out, and, according to the *Manufacturers' Record*, the structure itself, it is expected, will be ready for use in 1899.

"Nearly two years have been employed in working out the details of this immense structure, which is, in its proportions, far beyond any that has ever been built in the United States in the way of cantilever structures, and in some of its important features is entirely novel, especially in regard to the depth of water and the underlying material for the foundations."

The whole river-bed is of course deep alluvium, with no bed rock at any attainable depth for foundation purposes. There is, however, very fortunately, clean, sharp sand at very moderate depth, increasing in coarseness with increase of descent, and on this the foundations for the piers will be based, about 170 feet below low water.

"Caissons built of yellow-pine timber, firmly braced together, will support the masonry pier. The size of this caisson will be about 126 feet long and 60 feet wide, and will be 140 feet high. The caissons will be designed so that either one of two methods may be employed to sink them to their resting place, either by pumping out the sandy material of the bed by hydraulic process, or by dredging it by the dredging process through wells built in the caisson and also in the masonry above the caisson. It is expected, however, that, unless obstacles in the way of drift logs or wrecks of boats are encountered, the hydraulic process will be successful."

The bottom about the piers, and the banks near the bridge, will be heavily protected against scour, by willow mattresses and rip rap.

"The masonry piers resting on the caissons begin thirty feet below low water and rise ninety-six feet above this level. The masonry of these river piers will be twenty feet by fifty-four under the coping. They will be rectangular in shape from the top to within a foot of the high-water line, from which elevation to the timber work there will be a cut-water, or starling, on both up-stream and down-stream ends. The shore piers will be sunken either by the hydraulic process above described or by the plenum-pneumatic process, so well known to bridge engineers. The two shore piers, as they carry but little weight, will be much smaller than the main piers; they will be ten feet by fifty feet under the coping." The height will be eighty-five feet clear above high water.

The bridge is to be of the cantilever type, because the clear independent span of 1,000 feet required by the charter "was not considered practicable, or at least desirable, and, as the ground is so low and no wash exists in the entire country for anchorages, a suspension bridge was not practicable."

"The channel span will be 1,070 feet between centers of piers, or 1,044 feet in the clear at low water. It will be formed of two cantilever arms, each reaching out 270 feet from the piers and supporting a central span 530 feet long; the shore spans which act as anchorages of the cantilever arms are about 600 feet long; they are of such length and width that there will never be under any position of trainload any uplift at their shore ends. The outline of the top chord of the main bridge has been designed in graceful curves, rising from a height of 80 feet above the track at the center of the main span and ends of the shore spans to 160 feet above the river piers. On these piers are erected massive steel towers, formed of four posts firmly braced together."

"The river at the location is about 2,400 feet wide, a little less than half a mile. The entire length of the bridge and its approaches between the connecting points of the railroads on each side is about six and one-half miles. The length of the steel structure is a little over two miles, making it the longest in the world."

The New Lock at Sault St. Marie.

THE great lock in the canal around the rapids of the St. Mary's river has been formally opened for traffic; the lock formerly existing is still in use, and, it is understood, is to be maintained. It is not likely that navigation will again suffer such an obstruction and interruption as occurred in 1890, when the lock was damaged by accident, and a three-mile procession of delayed vessels congregated above and below before repairs were completed so that traffic could be resumed; but, in the event of such an improbability, a third route exists through the lock on the Canadian side.

To one unfamiliar with the conditions the triple provision seems unnecessary; but not to one who has witnessed the wonderful volume of traffic passing in both directions between Superior and the lower lakes. The converging lines from Michigan and Huron uniting in the Detour and passing through Hay Lake channel and the locks into the "unsalted seas" of the northwest assemble an aggregate of tonnage probably unparalleled in any artificial waterway in the world. The Sault canal has long outstripped the Suez in annual tonnage passed through, and in the fiscal year 1895 showed the magnificent figures of over 15,000,000 tons, valued at over $150,000,000.

Iron, copper, lumber, and wheat, or the products manufactured from them, are carried down; coal, machinery, groceries, and general supplies are returned in exchange; and the old town which was settled originally as a trading post at the "carry" around the rapids now centers about the modern counterpart by which the magnificent steamers of the new lake service are passed from deep-water navigation above to the deepened channels below the rapids.

The original lockage at this point was by a flight of two locks, built by the State of Michigan in 1855,—indirectly, that is, the work having been delegated by the

State to a company of eastern capitalists.

To these succeeded the single lock built by the United States in 1881, until recently the sole medium for both American and Canadian commerce. The gates of this lock closed a clear opening of 60 feet in width,—10 feet less than the old State locks; in the new lock just opened the width is increased to 100 feet, and the lock has a length of 800 feet.

It is provided with five sets of gates,—upper and lower guard gates in addition to the three gates properly belonging to the lock. Mild steel was the material employed for all five sets, for the reasons cited by *Engineering News* from official information as follows:

"Experience in France has shown that, at the present day, leaves approaching the size of those under consideration can be constructed much more cheaply of metal than wood. In the United States the cost of timber is not so great as in France, but it is continually increasing. If the gates of the new lock were to be made of wood to-day, they would need to be renewed in about twenty years, when the cost of timber would probably be so great as to compel the use of metal in the reconstruction, while the shape would have to correspond to the masonry and be still designed for the original wooden structure. Thus the shorter probable life of the timber gate, the difficulty in so assembling it as to carry its great weight rigidly without a roller, and the fear of trouble in future renewal caused the selection of mild steel as the material.

"Briefly described, the leaf is a steel structure having a framework sheathed on both sides with plates. It is curved in plain, the two leaves forming a continuous arch when closed. The upstream and downstream surfaces are portions of cylinders. The clear distance between the sheathing plates is 30 inches at the ends and 36 inches at the middle, this splay being given to make the interior more accessible and to allow for variations in the position of the curve of pressure. The body of the leaf is 43 feet high, surmounted by a footbridge 20 inches high, the top of which is level with the coping of the side walls. The chord of the leaf measured between the centers of the surfaces of contact at the quoin and miter posts is 56 feet 7.69 inches. The median circle measured between the same, a radius of 77 feet 3 38 inches, and subtends an angle of 42° 59′ 40″. With the adopted construction the depth of the gate recess from the inmost element to the plane of the face of the lock wall is 8 feet 7.13 inches. The weight of each leaf in air is 312,000 lbs.

"For uniformity and simplicity of construction the same form was adopted for all the gates, although the selection was originally governed by the great dimensions of the largest ones. The intermediate gate, 43 feet high, is a duplicate of the lower lock gate. The upper lock and upper guard gates are 26½ feet high, and are duplicates, and the lower guard gate is the smallest, being 25½ feet high.

2,404,657 lbs. soft steel at 5.9 cts. per lb..	$141,874.76
119,168 " high steel at 27¼ " " "...	32 473 28
36,167 " cast steel at 9¼ " " "...	3,345.45
8,665 " cast iron at 6 " " "...	519.90
5,322 " phosphor bronze at 35 c. per lb.	1,862.70
7,215 ft. B. M. oak timber at $60 per M..	432.90
28 pumps and fittings................	2,100.00
Total..	$182,608 90

Esthetics in Engineering Construction.

It is an encouraging sign of the times that beauty and dignity are gaining rapidly-increasing recognition as appropriate and, indeed, essential elements in important constructions of every kind.

It is not long since an award on competitive designs for a bridge was given to the competitor who had made it a point to consider esthetics as well as mechanics in completing his plans, and the reports appearing from time to time with reference to the new East River bridge give a lively hope that the commissioners will show at least as much wisdom and taste as was displayed by those in charge of a much less important structure in a much smaller town.

Washington bridge is a happy example of the result of collaboration between the artistic perceptions of the architect and the constructive ability of the engineer, and, while it may fall short of the perfection which might be reached by giving the artist a freer hand, it remains a splendid object-lesson in a comparatively new departure deserving of high commendation.

It is understood, for instance, that the original plan contemplated solid masonry approaches, and that to the late Mr. C. Vaux belongs the credit for the substitution of the graceful and effective stone arches.

The original Brooklyn bridge is splendid in its proportions, and has that grace which, as Mr. Gardner remarked in the August number of THE ENGINEERING MAGAZINE, is the almost indefeasible attribute of a suspension bridge; but in detail it is bald in the extreme, and the approaches are beneath contempt. Indeed, it is an inexcusable abuse of a good word to bestow the term "approaches" upon the corrugated iron monstrosities which seem designed to obstruct as much as possible both view and access at both ends of the bridge. The Poughkeepsie bridge, on the other hand, is purely an engineer's bridge, deriving whatever severe beauty it may possess—if that be any—from the harmony of correct proportions in the members of each truss.

But, to quote Mr. Gardiner again, "he would be a dogmatic engineer who should say that there is but one right way in which the materials that form the girders of a steel bridge can be disposed," and "he would be an incompetent engineer who should say that, in choosing between the forms that lie strictly within the lines of utility and economy, beauty may not also be sought and found."

The public interest displayed in the new bridge and its approaches suggests that the day has gone by when construction committees or commissioners can perpetuate monstrosities upon the people who must live or pass in sight of their work. We are losing the spirit of reckless haste which would accept as a satisfactory public building anything which would keep out the rain, and demanded nothing from a bridge except that it should support the passing load. We are beginning to question even the valid right of the stand pipe to stick up in gaunt and hideous nakedness, like a chimney from the infernal regions, and even the building of a factory is no longer supposed to be utterly beyond the influence of some considerations of beauty.

And all these signs are healthy, for they indicate an increasing solidity of the national character. We are beginning to realize that we are here to stay, and are building to last; and our increasing exaction as to physical structures is a symbol of a tendency which will have its manifestation perhaps more stoutly, but no less surely, in demanding and securing greater stability and higher perfection in our social and political structures.

The Great Siberian Railway.

ACCORDING to the latest reports, orders have been issued by the Russian government to hurry forward the completion of the Siberian Railroad, so that through trains may be run two years hence. The route has been altered; instead of going *via* Kabarosk to Irkutsk, the line will cut across through Manchuria, to Chita, and thence to Irkutsk, effecting a saving of fifteen hundred kilometers.

A road which can save a thousand miles by a change of location indicates sufficiently its magnificent proportions, but the Siberian Railway presents other points of interest, besides being what is supposed to be so dear to the American heart, a "big thing"; it is modelled in general on American types of construction, although possibly (as the *Fortnightly Review* states) the immediate model studied by the Russian representative engineers was the Canadian Pacific railway.

The construction appears to be substantial, though rough, with a rail of moderately heavy section well spiked, and about twelve very substantial ties to the rail. The station buildings are surprisingly good; the intention is to leave the finer work of surfacing and alignment to follow, bending all energies at present to opening the line for through traffic — quite after American precedent.

Apart from its great length, the work presents few features of engineering importance, and, considering the conditions throughout, appears much less of an undertaking than any of our transcontinental lines. The common conception which classes it as purely a military road is no doubt largely in error, and based upon mistaken impressions of the country traversed. The *Fortnightly Review* not inaptly styles Siberia "a Russian Canada," and the Russians themselves expect the opening of the line to develop remarkable natural wealth in the region the world has thought of as a dreary waste, but which is said to be rich in gold, silver, iron, coal, and lapis lazuli, and to possess opportunities for wealth in its fisheries, while there is no doubt that it has important agricultural possibilities.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

Bridges.

*6982. The Architecture of Bridge-Building. Ill. E. C. Gardner (Urging that more emphasis be laid upon esthetics in the construction of bridges). Eng Mag-Aug. 2800 w.

*7006. The Kistna Bridge, East Coast Railway, India. F. J. E. Spring (Illustrated description). Engng-July 3. Serial. 1st part. 2700 w.

†7063. A Concrete Foot Bridge. Arthur N. Talbot (Description of construction of a small foot bridge in the grounds of the University of Illinois, with discussion). Ill Soc of Engs & Surv -11 An Rept. 3500 w.

†7064. To Ascertain the Best Angle for Wing Wall of Bridge Abutment. John H Serviss (Concludes that the best angle for the wing is that which requires in construction the least amount of material consistent with stability). Ill Soc of Engs & Surv-11 An Rept. 500 w.

7090. Low Level Bridges in Queensland. A. B. Brady (Abstract of paper read before the Inst. of Civ. Eng. Illustrated description with statement of conditions that led to the use of these bridges). Eng News-July 16. 2200 w.

7210 Counterweighted Arch Bridge at Riesa (Illustrated description of bridge over the river Elbe having peculiarities in design and construction). R R Gaz-July 24. 1000 w.

7281. Widening an Iron Truss Bridge (Illustrated description of the changes to be made in the Washington Ave. Bridge, Minneapolis, Minn.) Eng Rec-July 25. 800 w.

7369. The Adopted Plans for the New East River Bridge (Drawings showing plan, elevation, and sections of what will be the longest suspension bridge in the world; and will have the longest span of any bridge save the Forth Bridge). Eng News-July 30. 400 w.

†7456. On Cantilever Bridges. Edgar Marburg (Historical and technical with diagrams, formulæ and practical remarks. Brief discussion). Pro Eng's Club of Phila-July. 5000 w.

*7478. Highway Bridges. Carl Gayler (Discusses a few points for improvement in the building of highway bridges, which may account for the limited success, and deals at some length with the present practice of structural engineers who have made highway bridges a specialty). Jour Assn of Engng Soc-June. 2800 w.

7481. The New Steel Arch Over the Niagara Gorge. Orrin E. Dunlap (Brief history of the present railway suspension bridge, followed by description of the new steel arch which is to take its place). Eng News-Aug. 6. 1700 w.

7488. The Coulouvreniere Concrete Arch Bridge, Geneva, Switzerland (Illustrated description of a concrete bridge of non-skeleton construction recently completed at Geneva, Switzerland). Eng News-Aug. 6. 1000 w.

7490. The Bridge Brake. Robert Grimshaw (Illustrated description of a device for preventing oscillations or undulations, applicable to almost any form of bridge construction). Eng News-Aug. 6. 1800 w.

7507. A Bascule Three-Hinged Arch (Description and figure of bridge designed by W. H. Breithaupt, to be built over Newtown Creek). Eng Rec-Aug. 8. 600 w.

Canals, Rivers, and Harbors.

7093. The Needs and Possibilities of Harbor Improvement at Chicago (A consideration of the more important engineering and commercial questions involved. Editorial). Eng News-July 16. 4000 w.

7209. The Improvement of the Delaware and Schuylkill Rivers. Walter Atlee (The paper gives some idea of the magnitude and difficulty of the work which has been accomplished. decribes the work and illustrates Philadelphia Harbor, gives costs and other interesting data). R R Gaz-July 24. 5000 w.

*7292. The Mammoth Hydraulic Dredge for the Mississippi River (Illustrated description of dredge and of the operation of dredging). Engng-July 17. 1400 w.

*7340. Rivers and Canals, and How They Serve Their Purposes (Review of work on this subject by L. F. Vernon Harcourt, with interesting extracts). Trans-July 17. 3000 w.

7363. The West Side Irrigation and Mining Canal in Wyoming and Colorado. Elwood Mead (Illustrated description. The most interesting feature is the extent to which wooden pipe has been utilized). Eng News-July 30. 1600 w.

Hydraulics.

*7470. Movable Dams, Sluice and Lock Gates of the Bear-Trap Type. Archibald O. Powell (Illustrated description of bear-trap gates, analyses, summary of equations for finding widths, application of bear-trap gates, etc). Jour Assn of Engng Soc-June. 11500 w.

*7471. Bear-Trap Gate in Davis Island Dam, Ohio River. William Martin (The difficulties encountered and their remedy). Jour Assn of Engng Soc–June. 1000 w.

*7472. Bear-Trap Gates in the Navigable Pass, Sandy Lake Reservoir Dam, Minnesota. Archibald Johnson (Description of the improved bear-trap, its main features, sheet piling, navigable pass gates, air bags and capstans, flumes, valves, etc., with illustrations). Jour Assn of Engng–June. 4000 w.

*7473. Marshall's Bear-Trap Dams. W. L. Marshall (General discussion and description, with mathematical analyses and illustrations). Jour Assn of Engng Soc–June. 7000 w.

*7474. Bear-Trap Weirs. W. A. Jones (Illustrated description of some new forms with practical considerations, analyses, etc). Jour Assn of Engng Soc–June. 4200 w.

*7475. Modified Drum Weir. H. M. Chittenden (Consideration of the modified drum weir; the principal difficulties in dealing with any of the bear-trap forms of movable gate are stated; and the advantages in this form are noted. Illustration). Jour Assn of Eng Soc–June. 1800 w.

*7476. Lifting Dam. Amos Stickney (The movable dam here described is one designed by the writer for closing the navigable pass at Dam No. 6, Ohio River). Jour Assn of Engng Soc–June. 1800 w.

*7477. A Design for a Movable Dam. B. F. Thomas (Describes a style of trestle applicable to any of the places now occupied by the Poirée trestle, and has the advantage of requiring a much less depth of sill for its protection). Jour Assn of Engng Soc–June. 800 w.

7483. Steel Lock Gates for 800×100 ft. Ship Canal Lock, Sault Ste. Marie, Mich. (Additional information, with illustrations, regarding the design and construction of these gates). Eng News–Aug. 6. 3000 w.

†7549. Flow of River Floods (A suggestion for investigation from the study of the landslip at Gohna). Ind Engng–July 4. 600 w.

Irrigation.

6998. Irrigation in Utah (Some interesting figures of results obtained as given in *The Utahnian*, having special reference to the work being carried out by the Mount Nebo Land and Irrigation Co). Eng & Min Jour–July 11. 700 w.

†7058. Sewage Irrigation for Profit Walter C Parmley (Discussion of the general irrigation question, and pointing out the conditions whereby even sewage may become a producer of wealth). Ill Soc of Engs & Surv–11 An Rept. 4000 w.

†7109. A Utah Attempt at Settling Contested Water-Rights W. P. Hardesty (Description of an attempt by Utah courts to seecure an accurate and scientific measurement of waters that had been decreed to parties in dispute). Am Soc of Ir Engs–April, 1895. 1100 w.

†7200. Methods of Irrigation. F. P. Hallahan (Describes the two methods in general use, and favors the modern method). Am Soc of Ir Engs–April, 1895. 700 w.

Miscellany.

†7059. A Topographical Survey of the State of Illinois. John W. Alvord (Some of the advantages of such a survey and its probable cost, with discussion). Ill Soc of Engs & Surv–11 An Rept. 4000 w.

†7060. To Lay Out a One Mile Regulation Race Track. D. L. Brancher (Four diagrams are given with directions). Ill Soc of Engs & Surv–11 An Rept. 900 w.

†7065. Wagon Roads of Illinois. P. C. Knight (Calls attention to some common errors in road construction, with theories of the writer in regard to the improvement of dirt roads). Ill Soc of Engs & Surv–11 An Rept. 1000 w.

7089. A Proposed Standard Specification for Portland Cement (Extracts from an interesting paper by William J. Donaldson urging the adoption by the United States of a standard specification for Portland cement, the use of which should be required in all works done under the direction of officers of the corps of engineers, also, by the Navy, Supervising Architects' Office, etc. Conditions, reasons, and copy of specifications, with arguments are given). Eng News–July 16. 2200 w.

†7198. The Application of Photography to Surveying. John S. Dennis (Facts about results that have been obtained in Canada by the application of photography to surveying). Am Soc of Ir Engs–April, 1895. 2500 w.

7241. Record of Steam Shovel Work; Ann Arbor Railroad (Abstract of a paper read before the Mech Engng. Soc., by H. E. Riggs. Tabulated records of work done on the Ann Arbor R. R. improvements, for seasons of 1894 & 95, with a variety of steam shovels). Eng News–July 23. 800 w.

*7409. Origin and Use of Steam Road Rollers. E. Purnell Hooley (Abstract of paper read before the British Assn. of Munic. and County Engs. Reviews the history, and the working and general usefulness). Munic Engng–Aug. 5000 w.

*7410. Portland Cement Specifications (Reviews article by William J. Donaldson, urging the adoption of standard specifications; gives full abstract of the paper; also the Philadelphia controversy over Portland cement). Munic Engng–Aug. 6500 w.

7416. A Steel Coal Trestle and Pockets (Illustrated description of a steel structure, recently constructed in Rochester, N. Y., designed to receive coal from a train, store it in pockets or yard bins, and rapidly deliver it by gravity, automatically screened, to the retail wagons). Eng Rec–Aug. 1. 500 w.

7486 Road Building in Lancaster, Mass. Harold Parker (From the "Journal of Massachusetts Highway Assn" The conditions of the country and the methods used in keeping about 100 miles of public highway in good order). Eng News-Aug 6. 900 w.

7506. The Strickler Tunnel (Built to increase the water supply of Colorado Springs. Map, profile of the tunnel location, view of the east portal of the tunnel and cross sections are given) Eng Rec–Aug. 8. 900 w.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading, and Architecture.

Interior Wiring.

ALL of the electrical papers do not print articles of much practical value some of the time, but some of them present good practical discussions all of the time. Among those of a practical character for the current month we note one under the above title in *American Electrician* for July, in which methods of wiring are classed in two systems, the object in view for either system being the most uniform distribution attainable consistently with convenient accessibility and control of switches and fuses. We have reproduced on a somewhat smaller scale the diagrams illustrating these systems.

What is called the "cabinet" system is shown in Fig. 1. In this system the bus-bars are inclosed in a small cabinet, the feeding being done with a pair of mains, from which branch-circuits are established with the lamps or with "sub cabinets," as illustrated in the diagram.

"The circuits are always controlled at the cabinets with a fuse, and often with a switch. These cabinets are cases built into the wall and finished in accordance with the wood work in the vicinity, and had best be arranged to lock, in order to prevent the intermeddling of curious or malicious persons."

The "tree," or feeder, system is illustrated diagrammatically in Fig. 2. In this system "large wires feed the center of the system, which consists of a pair of mains, and these in turn feed sub-mains, from which branch the taps supplying the lamps. This system is largely used in factories, machine shops, and weaving or carding rooms, where the lamps are so arranged that such a system is applicable, and where all of the lamps are to be used at once. For the majority of other places it is not suitable, except on a small scale."

But most frequently combinations of these two systems are employed, as in the modern tall office-building, wherein each floor is controlled at the dynamo switchboard by "feeding a cabinet located in a central position on the floor to be lighted, and from which the sub-feeders spread over the floor to supply the office circuits. First, there is always the main feeder, which carries the whole current used by the lamps. Then come the sub-feeders that carry the current of a portion of the lamps; and lastly the tap circuits. The main feeders are always the easiest to calculate. Taking, for instance, the feeders of Fig. 1, that feeding cabinet *A* carries the current of fifty-one 110-volt lights one hundred feet. Assuming the maximum variation of pressure to be five volts from bus-bars to lamps, we may allow two volts loss in these feeders, which leaves three volts for the taps and sub-feeders. The line loss is 2, the lamp-feet 5.100, and, applying the formula for 110 volts, $R = \frac{E}{NF}$, we have $\frac{2}{5,100} = .00039$ ohm per foot of wire, which is equivalent to No. 6 B. & S. wire, this being just a little large. If it were decided to have three volts drop on this feeder, No. 8 B. & S. would be the nearest size, it also being a little small. In this case it would be better to use the No. 6 wire, for it is always preferable to have the mains large rather than the sub-wiring, as the latter can be more easily changed if at any time it is desirable to increase the lights on the sub-circuits. Also, it is cheaper to scrap small wire than large. The little chandelier (circuit 2) carrying four lamps 20 feet away from the cabinet involves but 80 lamp feet, and the volts lost must be three in order that the loss be uniform from bus-bar to lamp socket in every case; applying the rule, the resistance per foot will be $\frac{3}{80} = .0375$. This is much higher than the resistance of No. 14 wire, but nevertheless we must use No. 14, because the insurance code permits no smaller. The lights on this chandelier will, therefore, burn above candle power. Circuit 3, which feeds cabinet *C*, figures out 1,690 lamp-feet. The line loss must be less than three volts, for we must have something for the inevitable loss in circuits 7 and 8, as we cannot make these wires of no resistance. Let the volts lost in circuit 3, therefore, be 2, and the resistance in ohms per foot is $\frac{2}{1,690} = .0011$ — most nearly No. 10 B & S. If we allow .75 volt for the circuits 7 and 8, the wires will be No. 14 on the fifty-foot circuit and No. 12 on the seventy-foot circuit respectively. The taps feeding the lamps are so short and carry so few lamps that it is probable that the wire would figure out nearer No. 20 than anything permissible. As before stated, No. 14 would have to be used, the drop through which would be negligible; but in all probability the contacts in the rosettes and sockets would absorb .25 volt so nearly that the lamp voltage would be within that amount of the rating."

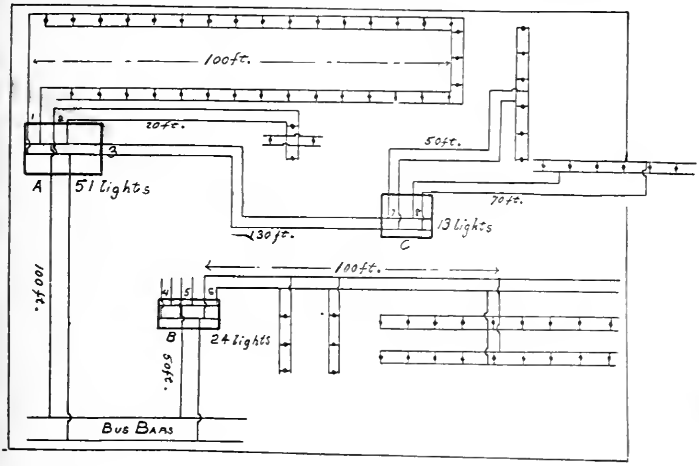


FIG 1.

In selecting wires, it is necessary to compromise between those much too large and those too small, but, in making such approximations, we should endeavor "to compensate . . . for enforced errors"; thus, if the mains must be larger than calculated, the subfeeders may be somewhat smaller. If, in the circuit marked 1 in Fig. 1, "we were to calculate the wire . . . with scrupulous accuracy, we would find that the wire between every lamp would be of a different size. This would be a difficult circuit to run, and would involve many joints."

This would be carrying accuracy to an uneconomical point. Practically, one size of wire would be used for all of these leads. Where, on one side of the circuit, the wire is too small, this error will be balanced approximately by the too large wire on the other side. Assuming the lamps to be "bunched together at a distance from the source of supply equal to one-half the

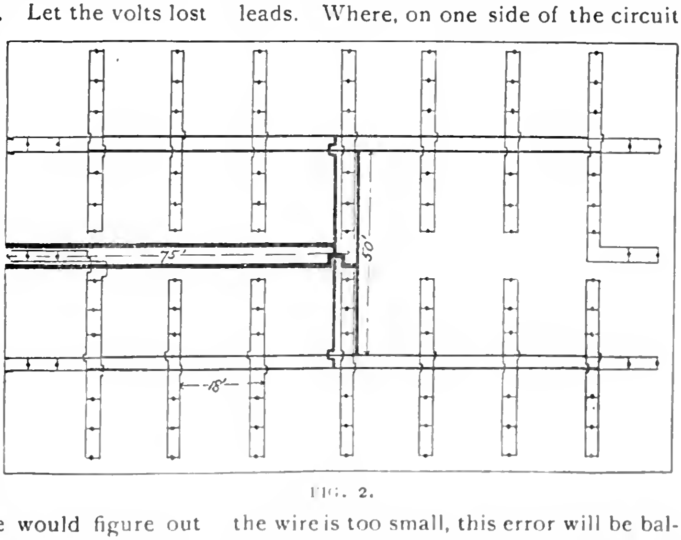


FIG. 2.

length of the circuit, the lamp-feet of the bunch may be found by multiplying this distance by the number of lamps. In the case under consideration "the distance is 100 feet, and, as there are 34 lamps, we obtain 3,400 lamp-feet. With three volts drop, the wire would have a resistance of .00088 ohm per foot, the nearest size being No. 9 B & S."

This style of wiring, called the "loop-

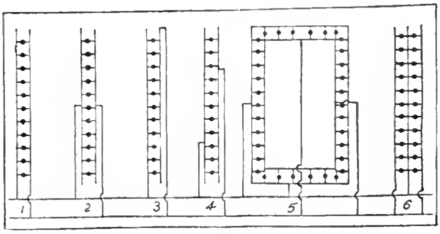


FIG 3.

circuit," is a favorite method; but such circuits, when they comprise many lamps and long distances, "call for a wire so large that it cannot conveniently fit in the lamp rosettes and fixtures."

Six examples of tap-circuits are shown in Fig. 3, and are explained as follows:

"No. 1 is the ordinary tap circuit fed at one end. Unless it is very short and has but few lights, the last lamp will burn at a noticeably less brilliancy than the first one. No. 2 differs from No. 1 in that it is fed in the middle. By this means the lamp at the end is not so far removed from the source of supply, and such a circuit could be twice as long as one of the No. 1 type without affecting the relative brilliancy of the lamps it feeds in any greater degree. No. 3 is the loop-circuit already described, and gives better distribution than No. 2. No. 4 gives even better distribution than No. 3, but is not as convenient, for it uses two single-pole branch blocks instead of one double-pole block. No. 5 is a method sometimes used on large rectangular chandeliers, rows of border lights, and in similar cases. It is not used often, for the numerous feeders must be brought to one point, in order that the circuit may have appropriate switch control. A loop-circuit would almost always be better. No. 6 is illustrative of a system which is adapted to either the three- or two-wire system; it is very important, for many plants are wired on this system, so that they can operate on the two-wire system with their own power, and, in case of a breakdown, the three-wire mains of the local lighting company could be called into play by the mere throw of a switch. It is obvious that this circuit can be fed in the same ways as 2, 3, 4, and 5, as may be desired."

To calculate an electric circuit: (1) Divide the circuit into sections of equal current carrying requirement as nearly as possible. (2) Calculate the lamp-feet of each section credited with the lamps on the tap circuits as well as with those it feeds directly. (3) "Choose a line loss. By carefully choosing this you may avoid odd sizes which are inconvenient and not largely kept in stock. Remember that the line losses by any path from switchboard to lamp socket should, theoretically, sum up to the same predetermined amount." (4) Calculate resistance, as above explained, and select the wire in accordance with suggestions previously made, but avoiding selection of wire smaller than is permitted by insurance rules.

It will be seen that the exercise of judgment is necessary all through the work. "The line-loss, lamp-feet rule applies only to cases where both wires of the circuit are considered."

Reduction of Speed in Electrical Machinery.

THE tendency toward lower speeds with dynamos is likely to run into extremes before it stops. Most fads pass reasonable limits before the absurdity of extremes impresses the average mind. It would be well if some one interested in this subject would compile authentic data from which some intelligent comparison of the respective durability of high-speed and low-speed dynamos could be made. In an article in *The Electrical World* (June 20) Mr. William Baxter intimates a belief that electrical engineers are already going too far in this direction, and gives some very good reasons for this opinion. He cites instances —not few—of high-speed dynamos that have run fifteen years and are still serviceable, and says that, while "many of these machines have solid bearings, . . . the original bushings" of some of them are "still in use." It is true that often the commutators on these machines have been several times replaced; but, since the introduction of carbon brushes, the wear in this respect has been greatly reduced, and there appears now no good reason why, with machines properly adjusted to prevent sparking, the wear of commutators should be excessive as compared with other parts. Comparing what are "considered high-speed dynamos" with dynamos connected directly to steam turbines, the speed of the former is very low, yet the wear on the steam turbine dynamos is not found excessive.

Electrical machines are simple. Practically they have but one moving part, and the motion of this part is the easiest possible to any mass,—rotation on a central axis. Nice balancing is, of course, essential, but, as this is a matter always carefully attended to by first-class manufacturers, Mr. Baxter sees no reason why a speed of "seven hundred revolutions per minute should bring any undue strain on a 100 k w generator designed for a speed of two hundred and fifty revolutions, if directly connected." This seems sound judgment as applied to the speed of dynamos. On the other hand, the reduction of speed in motors has been advantageous. Fourteen hundred revolutions for one horse-power motors, and twelve hundred for five horse-power motors, are recommended. It is not, however, the avoidance of injury to the motor, but the avoidance of complications for reducing the speed between the motor and the machinery which it is employed to drive, that is the main consideration in favor of lower speeds for motors.

Uses of Asbestos in Electrical Appliances.

An unusually interesting article on asbestos, by Mr. George Heli Guy, appeared in *The Electrical Engineer* (June 10). Mr. Guy describes the sources and methods of obtaining asbestos, and the processes it undergoes in the manufacture of the numerous articles for which it supplies all or a part of the material. Its applications are constantly increasing, and are well set forth in the article named, but the uses it finds in electrical appliances as given in this abstract are the only ones which find an appropriate place in this department.

"A form of asbestos very familiar to the electrical engineer is vulcabeston, which is composed principally of asbestos and rubber vulcanized. It is exceedingly tough and strong, dense, non-absorbent, and highly resistant to heat. It possesses great mechanical resistance to blows and pressure, and is readily manufactured in the forms most useful for electrical purposes. Vulcabeston is one of the standard materials for the insulation of dynamos, motors, arc lamps, converters, street-car controllers, switches, rheostats, thermostats, and many other forms of electrical apparatus. It is invaluable for the insulation of magnet spools, bushings, washers, commutator rings and sleeves, and controller parts, and for the covering of armatures.

"The newest departure in the asbestos field is the construction of electrothermic apparatus. The heating effect of thee lectric current is utilized by embedding the wire in an asbestos sheet or pad. The pad is used by physicians and nurses for maintaining artificial heat in local applications, and is said to be already largely used in hospitals. Another application of the same principle is to car-heaters. A sheet of asbestos, with the embedded wires, is clamped between two thin steel plates, and the portable heater thus provided, or a series if need be, is connected to the car circuit quickly and easily. It gives an even and healthy heat, and can be so regulated as not to overheat the car."

Doubtless new uses for this material in the electrical industries will yet be found, since in other kinds of work its applications are constantly increasing in number.

The New York Custom House 220-Volt Plant.

The feasibility of the employment of the 220 volt current for electric lighting in isolated plants has been satisfactorily demonstrated in the lighting and power plant of the New York custom house. All doubts of the advantages secured by this pressure in a combined light and power installment seem to have been set at rest by the operation of this, the first isolated plant of the kind installed in the eastern part of the United States. A brief, though very good, illustrated description of the plant is presented in *The Electrical World* for July. The light units and power units being each run at 220 volts, these units are equally adapted to supply either light or power, as occasion may demand, which innovation, we believe, is peculiar to this plant. Of the three units, two are used for lighting and the other for power, and it is immaterial which one is temporarily or permanently used for the power-supply. The light and power may at any time be taken from one and the same circuit, this having been arranged for, but not yet done.

The generating plant, according to our contemporary above named, has 6 generators, each of 75-kw. capacity, at 250 volts, running at a speed of 275 revolutions per minute. These machines are direct-connected to three 120-h. p., Harrisburg Ideal, self-oiling, automatic cut-off engines. The dynamos are of the ironclad type, designed especially for isolated lighting installations. The advantage possessed by this class of machine results from the use of a magnetic field circuit of cast steel of high permeability. Currents of air constantly circulate through the armature and the windings, thus affording satisfactory ventilation and a consequent reduction of heat. The armature is of the drum type, the conductors consisting of separately-insulated bars, embedded in slots on the armature core. The commutator is connected to the armature winding by flexible connections, obviating all danger from expansion and contraction of leads. Carbon brushes are used on these machines, and a new form of brush-holder provides means for carrying away the current from the carbon brushes with the least loss. The improvement consists in plugging into each brush one end of a short length of flexible conductor, the other end being placed in firm contact with the holder. This gives a connection of least resistance between brushes and holder, and at the same time gives a freedom of action to the brushes that is not obtainable by the ordinary methods. The brush-holder yokes are supported by the outboard bearings. The smoothness of action of these combination units and the freedom of vibration are remarkable, and it would be difficult at almost any time, with one's back turned, to tell whether they were in motion or not. The engines maintain a very constant speed, thus insuring a steady light.

The steam-generating plant is said to have presented some unusual difficulties, owing to irregularities of the space in which the boilers had to be set. All of these difficulties, however, were satisfactorily surmounted, and two batteries of two horizontal tubular boilers with Hawley down-draft furnaces were supplied by the Harrisburg Foundry and Machine Works. The switchboard—of Tennessee marble, without frame, but supported upon pedestals—has twelve double-pole circuit switches, three double throw, three-pole dynamo switches, three voltage regulators, three Keystone ammeters, two Keystone voltmeters, and one Keystone ground detector. Each of the double-throw switches is connected on one side with the power bus-bars, and on the other with the lighting bus-bars.

As there appears to be at present a strong leaning toward 220-volt incandescent lamps, the success of this installment is a matter of much interest to electricians, as an important departure in practice.

The Third-Rail System for Tramways.

The trial of the third-rail system at Nantasket Beach seems to have proved its engineering practicability for car-propulsion, but it leaves the commercial practicability yet an open question. As a means of propelling cars in cities, it has obviously much to recommend it. The unsightly and, it must be confessed, sometimes dangerous overhead trolley wires, which are the plague of fire departments, may thus be obviated to the improvement of streets and gratification of the public. As only the length of rail under the car is alive at any time, it would seem that the system is less dangerous than trolley wires; but the danger of running down people in the streets will remain, this being a matter independent of the mode of transmitting power to the car motors, and related strictly to speed of running, efficiency of brakes, and systems of management.

The genius has not yet arisen who can point out the way whereby the speed now allowed in many places can be maintained with immunity from danger to foot-passengers in much-frequented streets, the causes of which the people in part contribute through their personal negligence and carelessness. Brief abstraction of mind or inadvertence may yet leave time for recovery when street-cars run at the rate that formerly prevailed with horse-cars; but, when eight and, in some instances, twelve miles an hour are permitted, the liability to such accidents is increased in a ratio much larger than that of the increase of speed. The mechanical power required to stop a car by its brakes increases as the square of the velocity. The ability to think and act quickly in an emergency appears, with most people, to vary inversely with the precipitancy of the occasion, and this holds good both for motormen and those in danger of being run down. Hence even a small increase in speed of running increases the element of risk considerably.

But the third-rail system does not add anything to this danger by reason of its intrinsic character, and on its merits it will, we think, attract the attention of railroad men, its commercial success depending upon the relative first cost and its current cost for propulsion and maintenance.

Interior Lighting.

A WRITER in *Electrical Plant*, starting from the assertion that, unlike exterior lighting, interior lighting, on account of the complexity of conditions, is not amenable to mathematical computation, holds that there are two main requirements, which every one dealing with lighting questions should aim to secure. In the first place a certain intensity of illumination should be fixed upon as necessary to the convenient performance of the particular occupation or occupations commonly carried on in the room in question. Obviously, a greater intensity of illumination is necessary in some rooms than in others, as in places where very fine work, requiring a great deal of light, is performed; but, generally speaking, rooms for lighting purposes may be divided into three classes—viz., dwelling-rooms, workshops, and offices, for each of which a special intensity of illumination is desirable.

In the second place, a uniformity of illumination should be aimed at, and in those cases where only a good effect is required, and where work requiring high intensity of illumination is not carried on, the question of uniformity of illumination is the most important one for consideration. If the different points of light are so distributed that there is no one spot which looks darker than another, even if the absolute illumination is of a low grade, the room in question will have the appearance of being brilliantly lighted.

The author holds, also, that, in large rooms the ordinary method of fixing small units of light, at equal distances from each other, upon the ceiling is faulty, that uniform distribution is not thus secured, and that to approximate to uniformity of illumination the lamps must be concentrated towards the outer boundary of the area to be illuminated.

If instead of using five hundred 16-c.p. lamps distributed at equal distances throughout the area to be illuminated, twenty-five groups, of twenty 16-c.p. lamps, are arranged at equal distances throughout the area, the light at the central point is in the case of the grouped lamps less than in the first case; the fewer the sources the less the total illumination at the center, and although the points near the centers of the lamps will be much more strongly illuminated than corresponding points near the single lamps, the intensity at any point of minimum illumination will be less. The total candle-power will, however, require to be greater with few than with many lights.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Applied Electricity in the American, English and British Colonial Electrical and Engineering Journals—See Introductory.

Lighting.

7034. Meters. Jas. Milne (Touches on some of the more important meters in practice, making comparison with some of these meters from actual results). Can Elec News-July. 7500 w.

7073. The Electric Lighting of the Metropolitan Life Insurance Company's Building, New York (Description, with illustrations, of one of the finest plants in the city). Elec Eng-July 15. 1600 w.

7081. The 220-Volt Light and Power Plant at the New York Custom House (An illustrated description of the first and only plant in the east using this pressure). Elec Wld-July 18. 1500 w.

*7118. Arc Lighting from Alternating Current Lighting Stations. Frank Lewis (Brief discussion of the subject, making comparison with continuous current lamps). Elec Rev, Lond-July 3 1100 w.

7185. Alternating Current Machinery at the Buda-Pest Millennium Exhibition. Alfred O. Dubsky (Illustrated description. The first part describes the single-phase current machinery). Elec Eng-July 22. Serial. 1st part. 1800 w.

7317. The Detroit Municipal Lighting Plant (Description, with an account of the first year's financial operation). Elec Eng-July 29. 1800 w.

†7443. Recent Developments in Vacuum Tube Lighting. Ill. D. McFarlan Moore (Presented at meeting of Am Inst of Elec Engs., N. Y., with discussion. The object of the paper is not only to call attention to the advantages of vacuum tube lighting, but more particularly to a simple method of obtaining a current which will ultimately make such an adoption possible). Trans Am Inst of Elec Engs-March. 15800 w.

*7528. Electric Lighting in Belfast. Victor A. H. McCowen (Description of the system). Ind & Ir-July 31. Serial. 1st part. 5000 w.

Power.

6995. Electrical Equipment of Aluminum Works at Niagara Falls. Orrin E. Dunlap (Illustrated description). W Elec-July 11. 1800 w.

7033. Power Transmission by Polyphase E. M. F.'s. George White Fraser (Showing how polyphase currents have revolutionized the art of electrical generation, transmission, and utilization of power. Traces the progress of electrical working from direct current, through simple alternating, up to polyphase alternating, considers the complications that arise, the practical questions, and shows that varying conditions require the study of each case). Can Elec News-July. 4500 w.

7066. Electrical Transmission of Power in California. W. F. C. Hassen (Illustrated description of plant in Nevada County, with brief account of causes that led to its installation). Am Elect'n-July. 1000 w.

7068. How Is Motion Given to the Armature of a Direct Current Motor? Townsend Wolcott (The action of motors is explained and questions relating to it are discussed). Am Elect'n-July. 1800 w.

7069. Modern Commutator Construction (Illustrated description of various types). Am Elect'n-July. 2200 w.

7071. Faults in Dynamos (Difficulties that occur with dynamos that cause them to become inoperative, but are more properly classified as blunders rather than faults). Am Elect'n-July. 2000 w.

7074. Tests on Large Polyphase Transformers. Desire Korda (Experlmental results obtained by writer). Elec Eng-July 15. 1400 w.

7080. On a Winding for Motor Generators. P. M. Heldt (Describes a winding combining the advantages of the windings for both continuous and alternating currents). Elec Wld-July 18. 800 w.

7083. The General Electric Series-Parallel Controller for Four-Motor Equipments. William Baxter, Jr. (A description of the action of the controller switch and the commutating switch, with diagram of car wiring and controller constructions). Elec Wld-July 18. 3000 w.

*7087. Electric Transmission of Power in Mines (Illustrations from photographs taken in underground workings, showing applications made by Messrs. Siemens & Halske, of electrical energy to the driving of mine plant, and observations founded on a communication by Ingenieur C. Köttgen). Eng, Lond-July 3. 1800 w.

*7125. Accumulator Accessories (Dealing with the accessories which are necessary for successful accumulator working). Elec, Lond-July 3. Serial. 1st part. 1000 w.

*7132. Combined Light and Power Plants (Ways in which a combination may be effected. First part describes and illustrates the Hamburg plant). Engng-July 10. Serial. 1st part. 1700 w.

*7141. Alternate Current Transformers. J. A. Fleming (Cantor lecture delivered Jan. 20, 1896. Explains the action of the transformer. To be followed by other lectures on the construction, testing and employment). Jour Soc of Arts-July 10. 6000 w.

*7162. Some Notes on Rope Driving (The use of ropes in dynamo-driving, the dangers, matters that require consideration, etc). Elec Rev, Lond-July 10. 3500 w.

7177. A Mexican Transmission Plant. George J. Henry, Jr. (Illustrated description of a plant being erected in the state of Hidalgo in Mexico, to supply power to the mines of the Rio del Monte Co. One of the most remarkable installations so far made in any part of the world). Jour of Elec-May. 800 w.

7195. The Pittsfield Electric Company (Illustrated description of boiler plant, etc). Elec Wld–July 25. 800 w.

7228. The Progress Made in the Generation of Electric Energy and Its Application to the Operation of Motors During the Past Fifty Years (Illustrated review showing progress and extent of electrical industries). Sci Am–July 25. 3600 w.

*7249. On the Dissipation of Energy Caused by the Armature Currents in Electrical Machinery. Otto T. Blathy (Announcement of the discovery of an apparent new source of energy loss in dynamo armatures). Elect'n–July 17.

*7296. On the Transmission of Power by Alternate Currents. J. T. Morris (Read before the Engng. Soc., Univ. College, London. A few of the leading principles involved in the design of such power transmissions, and a few of the results arrived at in recent practice). Engng–July 17. Serial. 1st part. 1400 w.

7306. Electricity in Paper Making at Niagara Falls. Orrin E. Dunlap (Illustrated description of the plant of the Cliff Paper Co. of Niagara Falls). W Elec–July 25. 900 w.

7320. Test of An Otis Electric Elevator with Leonard Motor Control System. W. H. MacGregor and R. T. Kingsford (Test of an elevator in the Fahys building, Maiden Lane, New York, undertaken as a graduation thesis, with the only object to arrive at facts). Elec Eng–July 29. 700 w.

7321. Combined Electric Lighting and Traction Plants. John Hesketh and John H. Rider (Read before the Munic. Elec. Assn., England. In proof that a combined station is the right thing, though opinions may differ as to which system the combination should be carried out upon). Elec Rev–July 29. 2000 w.

7353. The Advantages of the Multipolar Type of Electric Machinery. William Baxter, Jr. (Showing the advantages to be numerous and the disadvantages of a doubtful character). Am Mach–July 30. Serial. 1st part. 900 w.

7398. The Fidelity Mutual Life Building (Illustrated description of the power plant of one of Philadelphia's largest office buildings). Elec Wld–Aug. 1. 1100 w.

7405. Power for Machine Tools. Leland L. Summers (Problems connected with the application of electric motors to the driving of individual machine tools; results of tests, experiments, &c). Elec Engng–Aug. 1300 w.

7427. How to Avoid Fly Wheel Accidents in Power Stations of Electric Railways. William Baxter, Jr. (Describes a simple magnetic cut-out, which, if connected with the circuits as explained, will render it impossible for a generator to act as a motor. Illustrated). Power–Aug. 2500 w.

*7441. The Dissipation of Energy Caused by the Armature Currents in Electrical Machinery (Editorial correspondence criticising paper by Otto T. Blathey). Elect'n–July 24. 1200 w.

7450. The Transmission of Electric Power from Niagara Falls to Buffalo (A transmission line of unusual importance to be ready for use in November). Elec Rev–Aug 5. 1100 w.

7451. Electricity in Mining. F. B. Phelps (A review of the growth of the use of electricity in the mining industry). Elec Rev–Aug 5. 1300 w.

7491. Rope-Driving Arrangements. W. H. Booth (An examination of reasons for a statement made in a paper discussing rope-driving as applied to electrical work, with suggestions of a better design). Am Mach–Aug 6. 1800 w.

7492. Electrical Tests of Power Required by Wood-Working Machinery at the Navy Yard, Washington, D. C. Reported by O. G. Dodge (Tests of circular rip saws, band saws, planers, boring machines, etc). Am Mach–Aug 6. 800 w.

7519. Zufikon-Bremgarten Three-phase Power Transmission in Switzerland (Illustrated description of hydraulic and electrical plant). W Elec–Aug 8. 800 w.

*7532. Electrical Factories and their Machinery (The first part describes the workshops of Messrs. T. Parker, Limited, of Wolverhampton, with illustrations). Elec Rev–July 31. Serial. 1st part. 1800 w.

7543. Electricity in Private Houses. Theodore Waters (Describes the use of electric elevators in private houses, and the arrangements for safety in operation, without the employment of attendant. Illustrates and briefly describes the fine facilities for lighting a country residence and other ingenious uses of electricity). Elec Wld–Aug 8. 1800 w.

7544. Alternating-Current Motors. Dugald C. Jackson (Read before the Northwestern Electrical Assn. Careful comparative tests of alternating-current motors, made in the laboratory of the writer by J. H. Perkins and W. H. Williams, with results and explanations). Elec Wld–Aug 8. 1600 w.

Telephony and Telegraphy.

*7116. Submarine Cables in War Time (Discusses the need of neutralizing submarine cables and gives extract from report of the Congress of the Chamber of Commerce of the Empire, showing the necessity of adding to and amending the present cable system of the British Empire). Elec Rev, Lond–July 3. 5800 w.

*7135. Australasian Telegraphy (The British telegraph interests as affected by the Pacific cable question. Urging a reduction of the Eastern Extension Co. in its Australasian tariff). Engng–July 10. 900 w.

7187. Mr. Delany on Government Telegraphy (Abstract of argument before the United States Senate Committee, with editorial favoring the machine transmission). Elec Eng–July 17. 2300 w.

7220. The Telegraph (A review of the history, with a short biographical sketch of S. F. B. Morse). Sci Am–July 25. 2500 w.

7223. The Submarine Cable (History, with map showing the position of cables now existing, and a section of the Steamship Niagara, arranged for laying the cable of 1858). Sci Am–July 25. 1700 w.

7237. The Telephone (Illustrated historical review). Sci Am–July 25. 1200 w.

*7250. Cable Specifications and Tests. Jos. A. Jeckell (Read before the Municipal Elec. Assn., with discussion. Specifications issued by those who know what they want, and are desirous of obtaining it on the most favorable terms, are considered). Elect'n–July 17. 3000 w.

†7402. The Delany System of Machine Telegraphy (Report of the Committee on Science and the Arts, on the invention of Patrick B. Delany. Accompanied by an illustrated description of the details of the apparatus and mode of operation). Jour Fr Inst–Aug. 2300 w.

7520. The Telegraph in China. From the *San Francisco Chronicle* (Explaning the difficulties in telegraphing in the Chinese language). W Elec–Aug 8. 500 w.

*7531. The Naglo Equipment for Telephone Exchanges. Hess-Raverot-West System. Julius West (Illustrated description of this system as applied to the experimental exchange at the Berlin Industrial Exhibition). Elec Eng–July 31. Serial. 1st part. 1000 w.

Miscellany.

*6981. The Era of Extravagance in the Electrical Business. Burton E. Greene (Showing why electrical industries were so long unremunerative, and the reasons for believing them to be now on a sound business footing). Eng Mag–Aug. 3100 w.

*7043. On the Properties of a Body Having a Negative Electric Resistance. Silvanus P. Thompson (Read before the Physical Soc. Considers what are the properties of a body having a negative electric resistance, if such a body can exist, and questions the validity of the reasoning employed in a recent paper by Messrs. Frith and Rodgers). Elect'n–July 3. 3500 w.

7082. Effects of Hysteresis and Foucault Currents on Polar Diagrams. Frederick Bedell and James E. Boyd (Notes some of the effects produced by hysteresis and harmonics upon polar diagrams). Elec Wld–July 18. Serial. 1st part. 800 w.

*7126. The Latimer Clark Standard Cell. J. Warren (Discusses the details of the named type of apparatus). Elec, Lond-July 3. 1500 w.

*7160. A New Lorenz Apparatus for the Determination of Resistance in Absolute Measure (Illustrated description). Elec Rev, Lond–July 10. 1800 w.

7188. The Jacques Carbon Battery. C. J. Reed (Description of experiments performed which determine the action derived from this cell to be thermo-electric). Elec Eng–July 22. 1800 w.

7190. The Roar of Niagara (Official report on the roar of Niagara Falls at the recent Elec. Ex. in New York). Elec Rev–July 22. 1000 w.

7191. The Rights of Electrical Companies. W. Clyde Jones (The design of the paper is to outline the course of judicial decision in a manner to be of service as general knowledge to business men and engineers engaged in electrical pursuits). Elec–July 22. Serial. 1st part. 1100 w.

7194. On the Measurement of the Insulation Resistance of Continuous Current Three-Wire Systems While at Work. Edwin J. Houston, and A. E. Kennelly (It is shown (1), how the individual leakage conductances may be approximately determined by varying the working pressure on one side of the system and observing the corresponding variation of potential to ground on the other. (2) How the resistance in and up to the ground of a grounded conductor under load may be measured from the central station). Elec Wld–July 25. 1400 w.

*7251. The Capillary Electrometer in Theory and Practice. George J. Burch (The first of a series of articles giving the main results of ten years of hard work. Describes how to make a capillary electrometer ; discusses the law, gives directions for producing photographic records, and describes his method of analyzing them). Elect'n–July 17. Serial. 1st part. 2200 w.

*7276. On Alternating Current-Rushes in Condensers. Bernard P. Scattergood (Investigations of a phenomenon noticed while making experiments on a high tension circuit). Elec Rev, Lond–July 17. Serial. 1st part. 2000 w.

7307. The Insurance of Electrical Plants. R. H. Pierce (Read before the Northwestern Electrical Assn. The problem of safety is the real question. If this fire hazard is small the rate of insurance should be comparatively low). W Elec–July 25. 1600 w.

7319. Lightning Arresters. W. R. Garton (Abstract of a paper read before the Northwestern Elec. Assn. The principle is explained, and the forms that have been considered standard, with reference to difficulties). Elec Eng–July 29. 1100 w.

7322. The Organic Membranes as Insulators. Benjamin Ward Richardson (Physiological observations are described in detail and conclusions given. Also editorial comments). Elec Rev–July 29. 1800 w.

*7360. The Electrical and General Engineering College and School of Science, Earl's Court, London. S. W. (Illustrated description). Elec, Lond–July 17. 2000 w.

7390. Nikola Tesla at Niagara Falls. Orrin E. Dunlap (Account of Tesla's first visit to the plant of Niagara Falls Power Co., with his impressions). W Elec–Aug. 1. 1300 w.

*7440. The Electromagnetic Theory of Dispersion. H. von Helmholtz (Presentation of a theory, with investigations). Elect'n–July 24. 4000 w.

7460. The Thermo-Tropic Battery and a New Method of Developing Electrical Energy. C. J. Reed (An interesting contribution pointing out an apparently new method of generating electric energy. The electric current is developed merely by the passage of heat from one conductor to another, separated by an electrolyte). Elec Eng–Aug 5. 2000 w.

*7539. An Electric Frequency Teller. Albert Campbell (Description of a simple, portable instrument devised by the writer, for the direct measurement of frequency). Elect'n–July 31. 600 w.

INDUSTRIAL SOCIOLOGY

State Ownership of Railroads.

IN discussing this subject Mr. Frank L. McVey, in *Gunton's Magazine* (July), frankly admits at the outset that "the State has stability, permanence, and the power to secure unity, more than any other agency within its jurisdiction." These are advantages not possessed by persons or corporations, but they are attended by still greater disadvantages, which Mr. McVey proceeds to discuss.

"If a government insists in managing the railroads, there are only two ways in which it can be done; either the State must own the roads and lease them to private companies, or it must own the roads and manage the traffic itself. In the first case the lessee would be responsible for very little, and free, after having sold the lines to the government, to make a profit without the risk and responsibility which owning them would involve. On the other hand, unity of management—the very thing for which government ownership is urged—would be missing. Such a plan would involve the disadvantages of both private and public ownership. Upon the whole, then, we are justified in dismissing this scheme and taking up the more feasible one,—that of owning and managing by the government. The advantages to be derived from such management are stated as follows: (1) the worst existing abuses of personal discrimination and sudden fluctuation of rates would be avoided; (2) the public business would be carried on for the public good, and no one would be given an advantage over another; (3) there would result a harmonious unity of system and management not now possible; (4) State and national politics and legislation would be relieved of the corrupting influences of the railroad; (5) there would be a saving to the whole country in the lower rates and better management of the roads by the government."

These are all the desirable results claimed for State ownership, and, if the fourth and fifth of them could be established as certain to follow, Mr. McVey evidently thinks that the case for paternalism would be made out. But neither in history or in the nature of things can be found any warrant for the belief that, under State ownership, railroad management would be relieved of political corruption, or be more economically conducted than it is at present. On the contrary, the history of experiments in State ownership compel the candid student to the exactly opposite belief.

Mr. McVey shows that the low passenger rates in Europe, which advocates of State ownership are fond of quoting, are possible because less service is rendered than in the United States, where higher fares are paid; and, further, that the amount of service is least in the countries where fares are lowest. Thus, in the United States in 1893, where 2.12 cents per mile is the average fare, "one train was run 10 miles for every man, woman, and child in the country"; in England, where the average fare is 2 cents per mile, one train was run only 7½ miles for each unit of population; in France (fare 1.325 cents per mile) the service is 7½ miles per unit of population; and so on, every country in which lower rates of fare prevail giving less service than any other where passenger rates are higher. The lesson this teaches is the correlation of rates of fare with train service rendered,—a law that can no more be evaded by State ownership than the law of gravity could be evaded by the enactment that the accelerative force of gravity should hereafter be more or less than what nature has made it. Moreover, it also shows that higher train speed is correlated with rates of fare, average higher speeds going with average higher rates, so that not only quantity, but quality, of service must necessarily be lowered with diminution of average passenger rates; and this quality of service extends not only to speed, but to all the equipment upon which the safety and comfort of passengers depend.

Losses of revenue to the State, cities, towns, and townships; the transfer of losses from private stockholders to the government; and the disabilities resulting from the fact that the State cannot be sued,— are other reasons cited by the author for deprecating State ownership.

The editor of *Gunton's Magazine*, in comments appended to the article, regards Mr. McVey's argument as a feeble one, and states severer objections.

"To buy the railways is a capitalistic investment three times greater than the subjugation of the rebellion, since it would require the government to incur debt to the whole value of the railways,—say, ten thousand millions of dollars.

"This sum, being three times as large as was the debt involved in the subjugation of the rebellion, which itself was large enough to send gold to a premium of 180, and to make our bonds worth only 40 cents on the dollar, would wholly extinguish, as the rebellion did until after the war ended, our power to borrow abroad. As we had to fight the war wholly with our own resources, we would have to buy the railways wholly with the resources of the American people. In short, the purchase by the government would consist in asking the very people who now own the railways—the Vanderbilts, Goulds, Sages, the Astors, Rhinelanders, Hearsts, Stanfords, Huntingtons, and Carnegies—to take the bonds of the government in such sum as would make it seem profitable to them to part with the railways. Who that has ever run in debt and felt the force of the maxim, 'the borrower is servant to the lender,' does not know that these capitalists, having loaned the government the means (credit) with which to buy the railways, would thenceforth own the railways as creditors more effectually than they had ever owned them as shareholders, for the government would need their skill and could only get it on their terms? Never has an aristocracy of barons been clothed with powers equal to those which these government magnates, selected from among the railway class, but dependent on federal appointment, would surely exert."

The same reasons exist for government ownership of any and all other large industries as are urged for State ownership of railways, and the system, once commenced, would inevitably be thus extended. The losses in railway investments that have been and are now borne by individuals would have to be made up by taxation or repudiation. "Either would be ruin and chaos to the government and to its creditors." The annual interest on a debt of $10,000,000,000 would exceed in magnitude any loan in a single transaction that could be made by any existing government. The present army of government employees would be reinforced by 800,000, increasing the present difficulties of the civil service four-fold, and bringing up the standing army of civilians in government employ to one million men.

"The scheme in its magnitude falls, like the project of the deportation of the African race, because its details involve it in a vastness which renders it unmeasurable and unthinkable. It is beyond the purview of intelligent reasoning mensuration, and is to be classed with such projects as draining the Gulf of Mexico and leveling the Alleghany mountains. It is quixotic, chaotic, and chimerical. It is not merely true that the event would be disastrous, but the attempt to enter upon the transaction, even on the part of a lunatic, could not occur in a lucid interval."

The Reversal of Malthus.

In *The American Journal of Sociology* for July Mr. Albion W. Tourgee begins a paper under the above title by an allusion to the great fall in the prices of agricultural products, not alone in the United States, but also in England, France, Germany, and Spain, and to the collateral fact that, while the public domain in the United States is nearing the point of exhaustion, "farming lands have become more and more unsalable." He mentions ex-Senator Ingalls as an example of a large number of economists who appear to think that this depression in prices is, in some dimly-perceived manner, wholly correlated "with the financial system that has developed in the last twenty years. Those who think this correlation exists (and they far out-number those who attribute the depression to other causes) seek either in a protective tariff or in currency reform "a restorative for all the ills with which the social body is now afflicted." While Mr. Tourgee readily admits that the financial system is a cause of some potency, he yet finds other causes, which are the outcome of social, industrial, and economic relations, and which are universal.

"The steady and remarkable decline in the value of farm lands in the United States offers the first and most reliable suggestion of a cause which cannot possibly be the result either of revenue legislation or financial methods. Farm products are the necessaries of life. Their consumption, in the main, varies with the number of consumers. It does not depend to any great degree upon their social or pecuniary conditions. There is no general lack of food, clothing, or sufficient shelter in any part of the world. Everywhere there is enough, and almost everywhere a visible surplus. The only deficiency is on the part of those who have not the means of obtaining their share of the general abundance. In other words, there is no lack of supply, but only of individual power to obtain a share of this supply. Even this element is not important enough to constitute any great factor in economic speculation. If all the people in the world who are known or supposed not to have enough and proper food, clothing, or shelter were fully supplied with these necessaries, there would hardly be an appreciable diminution of the existing store.

"As a consequence, we are facing for the first time in the world's history this condition: the world is able to produce, and actually does produce, more food than is needed to meet the requirements of the population of the globe. More wheat, corn, rice, meat, and other staple food-products are raised every year than can possibly be consumed. One-fourth of the arable lands of the United States might be abandoned, and the world still have enough. The immediate issue of this condition is the fall in prices of farm-products, and a necessary result of this fall in the price of farm products is a declension in farm values."

The theory of Malthus, which has been widely accepted by economists, appears to Mr. Tourgee to be refuted by existing facts. The Malthusian proposition is, in substance, that, while population approximately increases in a geometrical ratio, agricultural production increases only (approximately) in an arithmetical ratio; or, at least, whether these ratios be considered as wide of the truth or not, population increases faster than the earth's capacity to supply the wants of life, and hence, the time must sooner or later arrive when, without some limit to increase of population, the world must become over-populated. This is to say that excess of population beyond the capacity to supply the necessities of life is over-population.

"To day we are facing a situation which seems to be an exact converse of the premises on which this hypothesis was based,—one apparently establishing the fact that the world's labor, applied to and supplementing the natural capacity of the earth, has already produced more than enough of life's necessities to supply the actual population of the globe. and, moreover, that this condition is likely to prove continuing.

"A scientific survey of the food-producing capacity of the earth, even with little, if any, enhancement of the present supply of labor, makes it evident that the present supply might be largely increased—possibly doubled—within the scope of existing lives. Startling though the thought may be, the statement depends for its verification on a few simple and universally-conceded facts. We know now that the most productive portions of the earth's surface are, as yet, practically undeveloped. It is asserted by the highest authorities that the tropical regions of Africa and South America alone could supply food sufficient for the whole world."

The increase in the productive power of land by improved fertilizers and improved farming implements, since Malthus wrote, is estimated to be at least five-fold. The discovery of mineral oils has added to food resources large quantities of animal and vegetable oils formerly needed for lubrication of machinery and for illumination. The modern processes for preserving and storing food products have also added to the general stock a notable quantity of food that once went wholly to waste as food. Improved transportation has also added to the resources of the world much food formerly wasted where grown, because it could not profitably be taken to any market. Science and invention, the two great factors of production, were practically unknown to Malthus.

There is much to stimulate thought in Mr. Tourgee's paper. The remedies he suggests are summed up in the closing paragraph of his paper as follows:

"Protection for the home market; more intimate commercial alliance with nations whose needs are complementary in character with ours; restriction of production; the diversion of labor to fields of employment not immediately productive, and which minister to the public and personal enjoyment rather than material gain,—offer to us the natural and reasonable methods of adjusting our own industrial relations to these new inevitable conditions."

Is a Double Standard Desirable, or Possible of Maintenance?

ABLE replies to these questions were contributed to the July number of *American Magazine of Civics* by Mr. W. A. Richardson. These replies are prefaced with comments upon the inconsistencies of the attitude now assumed by the advocates of free silver coinage at the ratio of sixteen to one. Denouncing protection as wrong in principle and unjust in practice, the silver men gravely propose to protect the silver industry by compelling people to accept silver as money at nearly twice its actual commercial value. If this can be brought about, sales of silver bullion will cease in the United States, and the silver bullion wanted will be imported. But, as silver may be about doubled in value by having the government manufacture it into dollars, silver manufacturing by private establishments, which require investment of capital in stock and plant, will languish. We shall become the great dollar manufacturing nation of the globe; but the export trade in dollars will be small.

Again, the advocates of free coinage of silver at the ratio of sixteen to one maintain that they are friends, and are acting in the interests, of all those who live by mental or manual labor; yet it can be proved to a certainty that from the time the United States adopts this ratio, without the concurrence of other principal commercial nations, the wages of labor will almost immediately have less purchasing power than they have now, while any advance in wages will have to be struggled for, and the condition of labor would thus be injured, not improved.

"To most of us," says Mr. Richardson, "it is confusing to read in Walker that there is a demand for that amount of money which is required to do the money work and no more—that no more can be used; and then to read in Cernuschi and Tuck that there is an insatiable demand for money at the mint. It is confusing to read that free coinage would bring the silver dollar up to the value of the gold dollar; and then to read that it would be unjust to require the debtors to pay their obligations with the appreciated gold dollar. It is confusing to read that there is a divine relationship between gold and silver, and that in adopting the ratio of sixteen to one we but reënact a divine ordinance; and then to read that the ratio between the two metals is a mere matter of law,—that the ratio could be fixed at one to one, if all the nations would but join in doing it.

"To most of us there seems to be a contradiction between the claim that we adopted a double standard in 1792 and the claim that silver was made the standard by that law.

"It seems inconsistent to claim that the 'compensatory law' was deduced from the uniformly and universally practical working of bimetallism throughout thirty-five centuries of history, and to claim that

France alone maintained the parity of the two metals from 1803 to 1873.

"We cannot help wondering how it was that France alone, of all the countries under bimetallic laws, did all the work. We cannot help wondering how the United States committed a crime in 1873, if she had done nothing prior thereto toward keeping the two metals at a parity. We are puzzled to know why France, and France alone, is not responsible for all the evils that have come from the demonetization of silver, if she alone maintained it at a parity with gold prior to 1874,—nay, above gold in the ratio.

"The friends and advocates of bimetallism are as conflicting as the writers. One will lay the stress on the need of more money, and will plant himself firmly on the quantitative theory. One will lay the stress on the efficacy of the law, and will work himself up to a corybantic frenzy over the crime of 1873. While others will, indifferently, use the demand and supply argument or the fiat argument; will ply you with heartless figures, or poetically personify silver as a wronged goddess. We seek the truth, and, despairing of getting our confusions cleared by reading this literature, we go to history.

"For more than eight hundred years after the fall of the Roman empire the currencies of Europe, or, at least, of western Europe, rested on a silver basis." The concurrent use of gold and silver as a basis of currency failed uniformly in Florence and the other Italian republics, in the German States, in Austria, the Netherlands, Spain, England, and France, in spite of the great efforts to effect it. "All that these States succeeded in obtaining . . . was an 'alternate standard,'—now gold, now silver, but never both together." In 1798 England refused longer to mint silver, and in 1816 adopted the gold standard. The same results have followed succeeding attempts to yoke silver and gold together; only one member of the team does the pulling; like an ill-broken team, they cannot be made to draw together evenly. "First one money has been recoined, and then the other, in order to fit their weight to variations in relative value. Incessantly one of the moneys has become too heavy or too light," and, in accordance with the law of human nature, "the lighter money has driven the heavier out of circulation." Invariably it has been the worst money that circulated, wherever a double standard has existed.

The experience of the United States is no exception to the rule; neither is the modern experience of France, with its ratios of fifteen to one and sixteen to one.

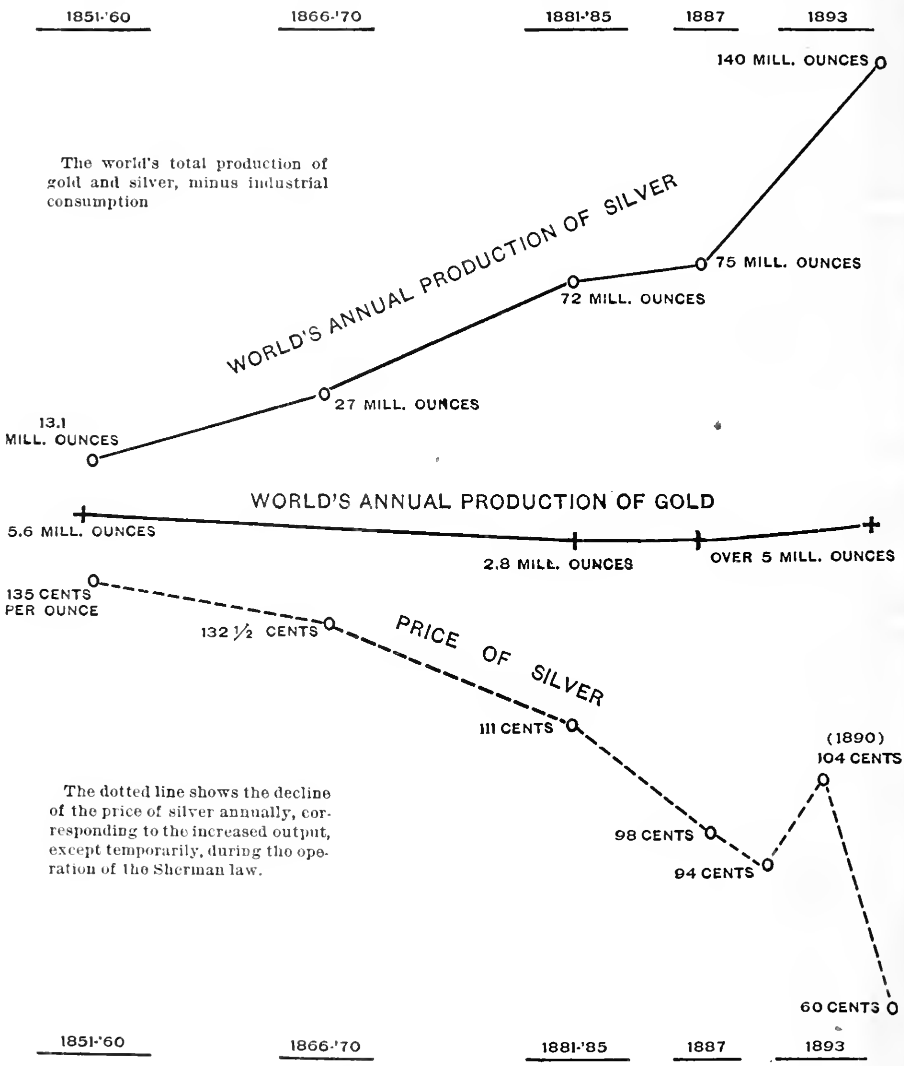
It seems almost impossible for a logical mind, in reading Mr. Richardson's able historical survey of attempted and defeated bimetallism, to reject his conclusions that bimetallism is not desirable even if possible; that it is only *nominally* possible; and that it "has never existed, unless you call the present system bimetallism, which it is in fact,—the system which makes one money the standard and the other the token." The account of past efforts to establish a double standard is extremely interesting. We pass it with the remark that many of those who think they know all about the "silver question" will find their self estimate not so flattering after a careful perusal of Mr. Richardson's paper.

Why the Commercial Value of Silver Has Declined.

In an able article entitled "The Silver Question," *Bradstreet's* (July 18) refutes the assertion that the discontinuance of the coinage of silver under the act of 1873 has caused the decline in the commercial price of silver. The fact is that this decline began before 1860, and has continued with the increase in production, although not precisely in the same ratio. One notable exception to this was the artificial rise in the price in 1890, as the effect of the Sherman act, when the price increased ten cents per ounce during a short period, after which it fell off even more rapidly than it had risen and has been falling ever since, with occasional slight upward tendencies.

To illustrate these facts, the article under review is accompanied by the chart herewith reproduced. The full line above that indicating gold production shows graphically the increase in the total output of silver bullion, while the dotted line below the gold line shows the increasing decline in price. These lines show production for both gold and silver exclusive of that used in the arts.

Of the significance of this diagram it is remarked that, "if it were wheat or corn, or iron or copper, or some other widely-distributed useful commodity concerning reference to this chart that the world's production of silver (exclusive of that used in the industrial arts) increased nearly elevenfold between 1856 and 1893, since which time the production has still further increased. It is also noticed that the world's production of gold (exclusive of that used in the industrial arts) fell off during the first two-thirds of the forty years referred to, since which time it has



which the tendencies of production and prices were indicated during the past forty years, it would, perhaps, be plainer to some people. In any event, we find by increased to nearly or about the same total per annum as that coined at the first date in the graphic illustration used. The striking feature of the chart is shown in the two lines representing, respectively, the world's production of silver and the course of the price of silver. It will be noted that the tendency of the latter was, during the period named, to fall off in about the same ratio as production increased, with one noteworthy exception,—in 1890,—when, by the operation of the Sherman act, for a brief period the price of bar silver was artificially forced up. Since that time the inevitable law of supply and demand has reasserted itself, and the price has declined as the supply has continued excessive. With reference to wheat, or cotton, or corn, or iron, an illustration of this character would draw from the most obtuse the conclusion that the cause of the depression in its price was the excessive, the absolutely unparalleled increase in production the world over.

"If further reasoning were required, it would only be necessary to point out that, whereas the average annual production of silver throughout the world from 1873 to 1893 was about 78,000,000 ounces, between 1851 and 1872 it was only about 21,000,000 ounces, pointing to a total annual increased average production of silver throughout the world in the latter twenty years as compared with the former of about 57,000,000 ounces, thus indicating conclusively the failure of the monetary demand for silver to employ the total output of the world, exclusive of the demand for industrial uses. To those who have argued that the increase in the world's population would naturally demand a corresponding increase in the supply of silver for money, it is only necessary to add that, whereas the population of the more enlightened nations of the earth increased only about 28 per cent. between 1873 and 1893, the world's silver output during that period trebled."

The accuracy of this record being admitted, the logical connection between production and price of the two metals seems indisputable.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Industrial Sociology in the American, English, and British Colonial Magazines, Reviews and Engineering Journals—See Introductory.

*6978. The Relations of Finance to Industrial Success. Henry Clews (Showing the dangers of over-capitalization in industrial enterprises and the importance of periodical statements of their condition). Eng Mag–Aug. 2300 w.

*6979. The Fallacy of Municipal Ownership of Franchises. Frank M. Loomis (Showing that municipal ownership is robbery under the form of law, and that municipal control is the true solution). Eng Mag–Aug. 3300 w.

*6984. The Natural Wealth and Industrial Possibilities of Cuba. Raimundo Cabrera (Reviewing Cuba's agricultural and mineral resources, and the opportunities for investment which they offer). Eng Mag–Aug. 3900 w.

†6992. The Reversal of Malthus. Albion W. Tourgee (The prevailing depression is treated as the result, not of local, but of universal causes. Instead of population outgrowing power of the earth to support it, the Malthusian doctrine has been reversed and power of production is now in excess of the needs of population). Am Jour of Soc–July. 4500 w.

†6993. Profit-Sharing at Ivorydale. I. W. Howerth (Presents the salient features and the results of one of the most successful and impressive examples of profit-sharing in the United States—that of the Procter and Gamble Company, engaged in the manufacture of soap, candles and glycerine at Ivorydale, Ohio). Am Jour of Soc–July. 4500 w.

†6994. Sanitation and Sociology. Marion Talbot (The ground is taken that improvement in health and prolongation of life should not be the sole aims and results of sanitation, but that it falls short of its possibilities unless a notable improvement in the habits and morals of the poorer class of society is evident). Am Jour of Soc–July. 2800 w.

*7049. Is the Foreigner a Menace to the Nation? W. G. Puddefoot (An argument favoring immigration). Am Mag of Civ–July. 4500 w.

*7050. Is the Double Standard Desirable and Is It Possible to Maintain It? W. A. Richardson (A résumé of the experiences of our own and of other nations, from which it is concluded that a fixed ratio between silver and gold cannot be maintained, even by international agreement). Am Mag of Civ–July. 5500 w.

*7051. A Woman's View of the Industrial Problem. Alice L. Woodbridge (A well written paper, in which reduction of hours of labor, the abolition of child labor, and the payment of the same price for the same work to both women and men are advocated). Am Mag of Civ–July. 2500 w.

*7101. A View of the Competitive Industrial System (Able editorial review of the proceedings and addresses delivered at a recent meeting of free traders in London, when a debate upon "The Ethics of Economic Competition" was held, in which Mr. Guyot and M.

Leroy Beaulieu participated). Jour Gas Lgt–July 7. 1800 w.

7102. The Silver Question (Diagrammatic representation of the output of silver and gold from 1851 to 1893, and of the prices per ounce of these metals during the same time, with explanatory text). Bradstreet's–July 18. 1600 w.

7103. To the Farmer, the Laboring Man and the Clerk. Edward Atkinson (The effects upon the interests of the classes named, which would result from free silver of full legal tender at the ratio of sixteen parts of silver to one part of gold). Bradstreet's–July 18. 1500 w.

†7168. A Record of Industrial Progress (A summary of the industrial progress of Japan, in its relation to British and East Indian commerce, and attempt to forecast the future). Ind & East Eng–June 27. 1700 w.

7180. The Foreign Commerce of New Orleans. Worthington C. Ford (The character, extent, and probable future of trade in this port are considered, with graphic indications of exports and imports, and distribution, with statistical tables). Mfrs' Rec–July 17. 2000 w.

7213. Capital and Labor. G. P. Clapp (The author thinks the present dearth of employment should be met by the universal adoption, by all civilized nations, of an eight-hour law). Can Eng–July. 2800 w.

†7260. Values of Foreign Coins. (Tabulated statement of values of foreign coins as annually estimated in accordance with the act of March 3, 1873, by the director of the mint for the period beginning Jan. 1, 1874 to April 1, 1894). Cons Repts–July. 1500 w.

†7261. Foreign Weights and Measures (Table embraces only such weights and measures as are given in consular reports and commercial relations). Cons Repts–July. 700 w.

†7264. Nicaragua: Natural Resources and Industrial Conditions; Opportunities for United States Trade; American Interests (Rates of wages; attitude toward foreigners; needed legislation upon emigration and naturalization: climate; water, public health, etc., are topics treated). Cons Repts–July. 4300 w.

†7265. Market for United States Goods in Nicaragua. (An able essay with statistics in tabulated form upon a variety of subjects connected with the establishment and increase of trade between the United States and Nicaragua). Cons Repts–July. 8000 w.

†7266. Cost of Goods Delivered in Nicaragua (Extensive list, with prices, compiled from an inventory of one of the principal importers at San Juan del Norte). Cons Repts–July. 2500 w.

*7274. Where Do the Immigrants Go? Cyrus C. Adams (Brief explanation of the distribution of the foreign element in our population. Effect of climate, accustomed vocations, location of different nationalities, etc). Chau–Aug. 2800 w.

*7356. New Customs Tariff of Victoria (Tabulated statement of duties now leviable on articles imported into the Colony of Victoria). Bd of Tr Jour–July. Serial. 1st part. 3500 w.

*7357. Tariff Changes and Customs Regulations (Russia, Denmark, Belgium, France, Portugal, Spain, Italy, United States, Uruguay, British India, Trinidad and Tobago). Bd of Tr Jour–July. 4500 w.

†7358. Is Japanese Competition a Myth? Robert P. Porter (This writer asserts that the Japanese are already in the American market with goods that for excellence and cheapness seem for the moment to defy competition. The kinds of goods are specified and described, and their prices stated). N Am Rev–Aug. 4300 w.

†7359. Natural Bimetallism. George H. Lepper (Makes a very plausible and apparently practicable suggestion of a plan whereby, with gold yet the standard, silver may be made the basis of legal tenders that shall be and continue practically at par with gold). N Am Rev–Aug. 1600 w.

*7392. Sweating System in New York City. Julius M. Mayers (A full and interesting description of the system in all its details. How it obtains and how it pays its labor. Based on testimony given before the New York State committee, appointed in March, 1895). Gunton's Mag–Aug. 2700 w.

*7393. Labor Problem in Japan. Fusataro Takano (The era of social evolution into which the Japanese have now come, will, it is predicted, soon bring the labor question to the front in Japan. The welfare of the working people has hitherto been totally disregarded). Gunton's Mag–Aug. 1600 w.

*7394. The Basis of Real Bimetallism. John Holley Clark (The belief that government fiat can create or add to value of money is treated as based upon a superficial view of phenomena. All this government can do is to certify value by coinage, etc). Gunton's Mag–Aug. 1500 w.

7407. Free Banking, Instead of "Free Silver," as a Cure for Hard Times. Austin W. Wright (An analysis of the present financial system as contrasted with a system of free banking). Elec Engng–Aug. 5700 w.

*7412. Demarcation of Work (Editorial discussion of one of the most difficult and unpleasant features of modern labor troubles). Engng–July 24. 2000 w.

*7444. The Development of Trade With Our Colonies (The proposed federation of the British Empire is discussed, and its difficulties considered. These are regarded as making the problem to be solved one of the most knotty and perplexing ever grappled with by statesmen). Ir & Coal Trs Rev–July 24. 3600 w.

*7445. The Labor Question in an English Foundry. R. A. Hadfield (A paper read before the Foundrymen's Assn., Philadelphia. Experiences of an English firm in averting strikes, shortening hours of labor and cultivating friendly intercourse with employees). Ir & Coal Trds Rev–July 24. 2000 w.

7499. Trade With Japan. D. Allen Willey (What a representative of the Bank of Japan tells the Manufacturers' Record. Southern cotton and other products find ready market there). Mfrs Rec–Aug 7. 1400 w.

MARINE ENGINEERING

Queer Doings in the Navy.

MR. ASA M. MATTICE, late of the engineer corps, U. S. N., and now a member of a shipbuilding firm in the eastern States, has recently addressed a letter to a member of the house of representatives (Hon. Francis H. Wilson) upon the condition of affairs in the United States navy, which he and many others regard as a disgrace to the government. The letter has been printed in pamphlet form and has had a wide circulation.

Approving the provisions of the bill introduced by Mr. Wilson and by Senator Squire (H. R. 3,618, S. 735), the purpose of which is to increase the number and improve the status of the engineer officers of the navy, Mr. Mattice directs attention to the fact that "the most powerful vessel of to-day has the same number of engineers that the smallest ironclads had in 1864, although the modern ship has over fifty times the engine power of the former. . . . Moreover, in 1864 there was not a compound engine afloat, in merchant or naval service. We have now passed through the era of the compound engine, and are in the age of the triple and quadruple expansion." Whereas forty pounds of steam was the maximum pressure in 1864, vessels in the navy now carry one hundred and sixty pounds. Twin screws have become the rule, instead of the exception, and triple screws have come into use. The multiplication of auxiliary machinery for ships has kept pace with all the other advances. The extent to which this has been carried is exemplified by the fact that, whereas "in 1864 few ships had any other than the main propelling engine and a couple of donkey pumps," the monitors having, "in addition, engines for working the turrets and for ventilating (not over a half-dozen engines in all), the Columbia has no less than ninety separate engines, having one hundred and seventy-two steam cylinders." The author next asks the significant question:

"Why is it that, with the departure of the old-time frigate and the advent of the modern steam fighting-machine, we have fewer engineer officers and more sailor officers, both in actual and relative numbers? Why is the number of engineers decreased in tenfold inverse ratio to the increase of their duties and responsibilities? Is it not evident that there is something radically wrong about the *personnel* of the service?"

To these questions the general answer is made that "the key to the whole situation may be found in the fact that the navy is managed, practically, by a certain clique of line officers, better versed in the arts of intrigue than in their own profession, who have, by hook and by crook, so managed to gain control of affairs that they are enabled to run the navy in furtherance of their own interests rather than the interests of the country. . . . This clique is not at all representative of the majority of their corps. The many line officers who are skilled in their profession and faithful in the performance of their duties—officers of the stamp of which Decaturs, Perrys, and Farraguts are made—should not be judged by this coterie of schemers, who disgrace their cloth."

From this general charge Mr. Mattice proeeeds to particulars. The secretary of the navy, nominally at the head of naval affairs, is, practically, "next to powerless," because the "boss" of the "clique or machine has the navy as completely in his personal power as any municipality is in the power of its local boss," and manages to have nearly all communications with the secretary, "incoming or outgoing, . . . passed through the meshes of its net. The secretary must depend upon naval officers for information and advice, and for the execution of his orders; and the 'machine' sees to it that these functions are performed, as far as possible, by its own members."

Specimens of these audacious methods

follow in Mr. Mattice's strong arraignment. We pass these, and also a statement of the *personnel* of the navy, only repeating the allegation that, while there are one hundred and thirty commanding officers, there are only seventy chief engineers,—"an anomaly that appeals directly to one's common sense."

Mr. Mattice says that his class graduated from the Naval Academy in 1874, "yet there are engineers of that class who have had more sea-service than some of the commodores who graduated in 1856. Eighty-four line officers were, by the last *Navy Register*, '*on duty*' in Washington,"—"about a third more than on board all the ships of the north Atlantic fleet."

It is further charged that, in addition to direct assaults upon the engineer corps, the machine has sought by various intrigues to throw discredit upon that corps. In sustaining this charge, the author alludes to the episode in the history of the Dolphin, built at the Morgan Iron Works by the late John Roach. He gives no names, but it will be at once unmistakably inferred by all familiar with naval affairs that it is to this incident that he refers. "The then secretary of the navy (Secretary Whitney) was generally credited with attacking the results of the previous administration for political effect. We regard it as greatly to ex-Secretary Whitney's honor that the following explanation of that affair is most probably the true one.

"Those . . . who knew the true inwardness of the affair knew that the secretary was grossly deceived by his advisers, . . . who managed to gain his confidence immediately upon his appointment to office. Their ultimate purpose was to discredit the engineers of the navy (who had designed the machinery and superintended its construction) as a means of helping through a bill introduced in congress to reorganize the navy in such a way as to put the engineers more fully under the thumb of the machine. It mattered not to them that they ruined the builder of the ships as an incident of their attack upon the engineers."

But it is charged, further, that they intrigued to get English firms to establish plants in the United States, and endeavored to induce the secretary to purchase foreign machinery in preference to American. In proof of this, letters from a line officer in London to the navy department are quoted.

Instances of unjust discrimination between the engineer corps and the line officers in the imposition of penalties for dereliction of duty are recounted. These examples are flagrant, and well worth careful consideration, but we cannot quote them. We can only contrast the penalty of one year's suspension from rank and duty imposed upon an engineer for not leaving his post until relieved, when ordered to leave by the officer of the deck, in direct contravention of the articles of war, and the sentence imposed upon a lieutenant for the second offence of drunkenness on board ship, which was one year's suspension from rank and duty on "waiting orders" pay, with loss of promotion during that period, but with a recommendation of clemency appended. The other instances cited, illustrating the difference with which naval courts martial regard offences committed by engineers and officers of the line, are equally flagrant. As a result of most glaring injustice, one able and estimable chief engineer became a physical wreck, and died in an insane asylum.

This letter is, in many ways, an important document. It is well written. Its facts are well selected for revealing existing abuses, and, like an X-ray photograph, it portrays the inner frame-work, unobscured by the plausible outer covering that so often hides actual facts.

Speed of Transatlantic Vessels.

COMMENTING editorially upon the records of the more recently built transatlantic steamships, *Engineering* (July 3) notes the fact that a period when the ocean is comparatively free from ice, and the Newfoundland coast is free from fog, follows the early summer, and constitutes what it calls "the season of short runs." During this time everything is usually favorable to the making of the quickest voyages. Notwithstanding that the earlier period is not so favorable, the fact that some of the ships made new records this year before the first of July is noted. But the opinion seems to be entertained that the struggle to exceed, or even to rival, such speeds will not be maintained in future construction. On this point it is said that attempts to excel what has now been done "would involve a large capital cost, as well as heavy running charges, and, although it might be possible to more fully utilize the ships by a shorter stay in port, as in the case of the American boats, which make four runs for every three of a Cunard liner, it is questionable if even then the margin of profit would compensate for the heavy outlay. Certain it is that the North German Lloyd, as well as the American line, have ordered ships since the advent of the *Campania* and *Lucania*, and they are content with 21 instead of 22 knots. The four new mail liners soon to be constructed by the Allan Line for the Canadian Pacific mail service will also be run at this more economical speed. The runs of the past week or two show the economy of this speed. The *Campania* made her home run last week in 5 days 12 hours 32 minutes, which is 36 minutes better than any previous passage on the long route. During this time she steamed 2,898 sea miles, so that her mean speed was 21.86 knots. Her day runs were 434, 519, 514, 510, 519, and 402, the first and last being incomplete days, while the others were of about 23 hours 10 minutes' duration. Now, the *Teutonic*, of the White Star Line, covered the same voyage in about 10 hours' more time; her actual record was 5 days 22 hours 23 minutes, during which she steamed 2,892 miles, the mean speed being 20.31 knots. The American liner *St. Paul* has also been making a record run from Southampton to New York, covering 3,113 sea miles in 6 days 7 hours 14 minutes, equal to a mean speed of 20.58. This is 2 hours 27 minutes better than the previous best run between the ports. At the same time the *Lucania* made on one day 560 miles, and the *St. Louis* 520 miles. The *Campania* made 524.8 sea miles per day of 24 hours, or 21.86 knots; the *Teutonic* 487 miles per day, or 20.31 knots; and the *St. Paul* 494 miles per day, or 20.58 knots The *Campania's* performance is magnificent; but it is, of course, largely a question of power, and it is noteworthy that for 6.2 per cent. greater speed the *Campania* has 40 per cent. more power, and consumes at least an equally larger proportion of coal. This, of course, is partly due to greater size; but the American boats carry a greater number of passengers per ton."

It is thus evident that the limit of attainable speed consistent with a satisfactory commercial profit has nearly or quite been reached, and that the speed now attained might profitably be reduced. Of course, pride has had something to do with the effort to increase speed; but commerce is generally indifferent to pride or sentiment of any kind. Profit is what is sought in business, and mârine traffic cannot long be made an exception to the general rule.

English Shipbuilding.

THE extent to which the English shipyards have monopolized the shipbuilding industry is strikingly illustrated by returns published in *Lloyd's Register*. Three-fourths of all the steam tonnage (excluding vessels of one hundred tons and under) now constructed in the entire world is built in the yards of the United Kingdom. Here are some of the figures as summarized from *Lloyd's Register* in *Machinery* (London, July 15).

"At the close of the quarter which ended on the 30th of June there were in course of construction in the United Kingdom 394 vessels of 774,012 tons gross. These figures, as compared with those of the corresponding period of last year, show an increase of 67,000 tons, whilst, in comparison with the returns of the quarter ending March of the present year, the increase is 9,000 tons. It is interesting to note the marvellous revolution that has taken place within the last quarter of a century in the material of which the English commercial marine is built. Of the 394 vessels under construction in June, 313, with a gross tonnage of 741,313, were of steel; 27, with a gross tonnage of 4,026, were of iron; 2, with a gross tonnage of 150, were of wood and composite. Clearly, the 'wooden walls of Old England' for ocean traffic will, in about half a century, be as much of a curiosity as Nelson's 'Foudroyant' or a viking's galley! In sailing vessels the disparity is not so great, the return being, of steel, 29, with a tonnage of 25,964; of iron, 1, with a tonnage of 226; of wood and composite, 22, with a tonnage of 2,333. The large majority of these vessels have been under the supervision of the surveyors of *Lloyd's Register*, in order to obtain a classification by the society, 290 ships, of 554,192 tonnage, having fulfilled the necessary conditions. Of the total number of vessels building in the United Kingdom under home orders and for sale, there are 232, with a tonnage of 396,097; and for foreigners and the colonies, 58, with a tonnage of 158,095. If we analyze the figures more closely, we find that, although the United Kingdom takes the lion's share, there is no country with a bit of coast or a port that is not a customer. Naturally, Englishmen come first, with 230 steamships. The colonies take 8, the United States 3, Brazil 7, France 2, Germany 18, Holland 3, Japan 5, and Russia 15. It may be interesting, as showing the increase in dimensions and carrying-power of the steamship of to-day, to mention that, of the vessels enumerated, 47 have a tonnage of 1,000 to 1,999 tons, 44 of 2,000 to 2,999 tons, 55 of 3,000 to 3,999 tons, 18 of 4,000 to 4,999 tons, 25 of 5,000 to 5,999 tons, 8 of 6,000 to 6,999 tons, 6 of 8,000 to 8,999 tons, whilst 1 is over 10,000 tons."

The above enumeration takes no account of twelve large warships now building in government dock-yards, or of eighty-six warships now building in private yards for the British and foreign governments.

A Great Loss.

An exemplification of the sudden and strange mutations to which human life and all its activities are subject occurred in July. Scarcely the July 10 issue of *The Engineer*, containing an elaborate illustrated description of the greatest ship-building establishment in the world, had been laid upon our table, when the New York morning papers announced the nearly total destruction of the works by fire. The great industry which met with this calamity is the shipyard and works of Messrs. Harland & Wolff, Belfast, Ireland. This establishment employed just before the fire no less than 9,000 workmen and apprentices. Some statistics of output are interesting. To fully understand their significance it must be remembered that this concern not only builds the hulls, machinery, and boilers of the vessels, but also manufactures all the fittings. During the five years ending 1884 the output amounted to no fewer than forty-two ships of an aggregate tonnage of 105,625 tons, and within the three and a-half years immediately following that period the firm began, completed, and launched thirty-four vessels of a total register of 89,770 tons. During the three years ending 1890 thirty-one vessels were launched, having an aggregate tonnage of 126,175 tons. During the years 1890 to 1894 it had turned out the greatest tonnage of any concern in the United Kingdom, and was prevented from doing so in the year 1895 also only by the great strike, which delayed the launching of several vessels. Messrs. Gray, of Hartlepool, headed the list in that year. During the present year, up to date, the firm has launched about 47,000 tons of shipping. This includes the peninsular and oriental steamship China; the new vessel Canada for the Dominion line; two large cargo boats for Messrs. Bates, of Liverpool; the European for the West Indian Pacific Company; and the Conic for the Belfast Steamship Company. There is also in course of construction the Pennsylvania for the Hamburg-American line, which will be the largest cargo boat in existence, having a tonnage of 11,320 tons; length between perpendiculars, 560 feet; breadth, 62 feet; depth, 42 feet. Also several vessels for other companies.

All of the vessels of the White Star line were built in this establishment, which, since the organization of the firm, has built ocean-going vessels of an aggregate capacity of nearly one million tons. In regular course fourteen or fifteen large steamers are annually turned out of these works.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Marine and Engineering Journals—See Introductory.

*7008. British and Foreign Shipping Competition (The extreme probability that foreign competition will increase is noticed, the stringency of the rules restricting British owners is deprecated, and special privileges granted to foreign vessels are condemned). Engng-July 3. 2000 w.

*7010. The French Battleship "Jauréguiberry" (Describes the armament and the steam generating outfit, the latter being of special interest with reference to a recent accident which occurred therein, resulting in the death of several stokers). Engng-July 3. 800 w.

*7011. The Classification of Warships. Francis Elgar (Read before the Inst. of Naval Architects. The various systems in different countries and the difficulties attending such classification are ably discussed). Engng-July 3. 6500 w.

7047. The Engines of the St. Louis and St. Paul (Illustrated description). Sci Am-July 18. 1200 w.

*7123. The Maintenance and Repair of Marine Boilers. J. F. Walliker (Paper read before the North-east Coast Inst. of Engs. & Shipbuilders. Discusses not only the topics named in title but also design and manufacture). Prac Eng-July 10. 1800 w.

*7133. The Argentine Cruiser "Garibaldi" (Illustrated description). Engng-July 10. 400 w.

*7138. Belfast and Its Industries (Illustrated description of the port of Belfast and the shipbuilding works of Messrs. Harland & Wolff, Limited). Eng Lond-July 10. 6000 w.

7182. A Revolution in Shipping Facilities. Albert Phenis (Port Chalmette, at New Orleans, its docks, wharves, warehouses, compresser and elevator. The great work of the New Orleans and Western Railroad and its destined influence upon the commerce). Mfrs' Rec-July 17. 5500 w.

7204. A Compound Yacht Engine (Illustrated description). Am Mach-July 23. 600 w.

7218. The Transatlantic Steampship (Historical development during seventy-five years. Ill). Sci Am-July 25. 3500 w.

7231. Naval and Coast Defense (History of the development of the modern warship, with numerous illustrations). Sci Am-July 25. 3800 w.

7235. American Shipbuilding (Illustrated historical sketch). Sci Am-July 25. 2000 w.

†7267. Port of San Juan and the San Juan River (Translation of a communication published in *El Ferrocarril*, April 18, 1896). Cons Repts-July. 1700 w.

*7289. Shipbuilding—British and Foreign (Review of returns in Lloyds register, showing a more satisfactory condition in the English shipbuilding industry). Mach, Lond-July 15. 1300 w.

*7299. New Engines of the White Star Liner "Germanic" (Illustrated detailed description). Eng, Lond-July 17. 1200 w.

7347. Hydraulic Lift Dry Dock at the Union Iron Works, San Francisco (Illustrated description). Sci Am-Aug 1. 1000 w.

7361. The Lake Fleet of To-day (Review of the changes in craft employed in the lake commerce that have occurred since 1870). Sea-July 30. 900 w.

*7386. Speed Control of Modern Steamers. M. L. Wood (Extract from paper presented to the U. S. Naval Inst. Describes and illustrates a device for controlling speed and direction of the engines of a steamer directly from the bridge or pilot house instead of from the engine platform, and states advantages claimed for the method). Am Eng & R R Jour-Aug. 1900 w.

*7411. H. M. Torpedo-Boat Destroyer "Janus" (Illustrated description). Engng-July 24. 800 w.

*7430. Atlas Bronze (A description of this high tension bronze and of tests of propellers made of it, and a list of vessels whose screws are made of this alloy). Eng, Lond-July 24. 1200 w.

*7495. H. M. Torpedo-Boat Destroyer "Janus" (Illustrations and description of the engines and boilers of this vessel). Engng-July 31. 2300 w.

*7498. Unusual Corrosion of Marine Machinery. Hector Maccoll (Paper read before the Inst. of Mech. Engs. A short description of an instance where the action of corrosion was so widespread, so rapid, and so powerful as to be somewhat interesting to engineers). Engng-July 31. 1600 w.

*7500. Efficiency of Combustion and Higher Steam Pressure in Marine Boilers. J. R. Fothergill (Read at meeting of North-east Coast Inst. of Engs. and Shipbuilders, Cardiff. Discussion of the present type of boiler, and related questions). Steamship-Aug. 2800 w.

*7501. The New Steamship "Albertville" (Description of a vessel built for the line between Antwerp and the River Congo). Steamship-Aug. 1700 w.

*7517. The Manufacture of Welded Iron and Steel Pipes (Discussion of paper read before the Inst. of Engs. and Shipbuilders, in Scotland). Engs Gaz-Aug. 4000 w.

*7550. Steam Pumping Arrangements in Screw Steamers (Illustrated description). Eng, Lond-July 31. Serial. 1st part. 2300 w.

*7553. The Santa Fe, Torpedo-Boat Destroyer (Illustrated description). Eng, Lond-July 31. 1200 w.

*7554. Ventilation in Warships (Editorial discussion of much needed improvements). Eng, Lond-July 31. 1400 w.

*7556. The New Admiralty Offices (Illustrated description). Eng, Lond-July 31. 1600 w.

MECHANICAL ENGINEERING

Test Sections.

ENGINEERS throughout the world are recognizing the desirability of uniformity in tests of materials of construction. Quoting some forcible remarks of Herr Schroedter, secretary of the Society of German Iron Masters, upon the desirability of a uniform method to replace the great variety of specifications for testing now in use, Mr. P. Kreuzpointer (*Iron Age*, July 23) thinks the variety of specifications in use "indicate a variety of opinions among engineers of the properties and behavior of metals.

"In one point, however, there is uniformity of opinion,—namely, that the testing of full-sized structures or members of structures would give the most reliable insight into the quality of materials. Science demands the largest-sized test piece to satisfy her wants fully. However, economy steps in at this point, and says that this cannot be done, because it would be too expensive in labor and material to make the testing of large masses a regular practice. In our perplexity we go to consult experience for advice. And right well we did asking her opinion, for she told us that, while it is of course quite satisfactory to test full-sized material, she knew, from closely observing the properties of metals, that it is not necessary for practical purposes to go to that expense; but she was sure that a piece of metal of a suitable size, taken from the material intended to be used, would give us safe and reliable information for nearly all of our needs. If, however, experience continued, we go below that size, we get on the wrong path, and the further we depart from the proper point or source of information the more we are led astray and run the risk of accidents and injury, if not disaster. Why, do we ask, should this be so? Because, experience tells us, accommodating as metals are in very many ways,—more so than many an engineer has any idea of,—they are very set in certain characteristics, one of which is a decided objection to be interviewed and interrogated in a way that circumscribes and hinders free expression and movement. If put too much under restraint while being examined, metals are very apt, says experience, to assume a strained, unnatural position, appearing to the examiner to be something different from what they really are. The main point to be borne in mind, experience continues to explain, is that all metals are plastic, the difference of plasticity of the different metals being one only in degree, but not in kind, the softest metals being the most plastic. As a consequence, our method of testing and examining must be such as to give a metal the greatest freedom to exercise its plasticity, or else we get erroneous results. Hence the importance and necessity of reading and interpreting elastic limit, yield point, tensile strength, elongation and contraction of area, rightly and correctly, because these phenomena are functions of the plasticity of metals, and, if we obstruct plasticity, we alter those factors by which we measure the worth and value of a given metal for a given purpose. And to the degree these factors or measures of quality are altered by improper methods, to that degree our conception of the value of a metal becomes misleading."

There is a very strong flavor of practical good sense in the above quotation. Seeking for the way in which the conclusions of experience have been reached, it is found in observations of rate of flow of metals in test pieces of different shape; and rate of flow, though not the same as, is strictly correlated with the degree of plasticity; or, technically, rate of flow is a function of plasticity. Mr. Kreuzpointer believes that tests of small pieces do not give as reliable results as tests of larger specimens. On this point he says: "Suppose we measure the ductility of steel while tested in the whole plate, in a length of eight inches, and get as a result twenty per cent. Then we cut up that plate, supposing it still intact, into pieces of various forms, widths, and lengths. On testing these pieces, we would get a greater per cent. of elongation in every piece than that obtained in the whole plate." Explaining why this can be, the author devides the process of testing into four stages: (*a*) From beginning of test till the elastic limit is reached; (*b*) passing the elastic limit to the yield point; (*c*) passing the yield point up to the point of maximum load; (*d*) the most extensive stretch from the point of maximum load to the point of rupture. It is intimated that the relations existing between these several stages vary with form and size of test pieces, and that the element of time must also be considered. "If, by short and narrow test pieces, by fillets and corners, we hinder and interfere with the free and natural movement of the particles of the metal to be tested, if the number of particles taking part in the work of resistanee is proportionally very much smaller to the load applied to tear them apart than the number of particles is in proportion to the load pulling at the full-sized beam, axle, etc., then the particles in that illy-proportioned test piece are forcibly torn apart before they have had time to stretch and slide according to their nature," and our inferences from the results are liable to be erroneous. It is therefore concluded that "the testing of a full-sized beam, plate, axle, tire, eye bar, &c., is the most satisfactory manner of testing, because of the quantity of metal in the part under stress, which quantity allows the distribution of the strains over a large area or section of the total metal, and permits each particle or crystal to take part in the work of resisting the efforts of the extraneous forces to pull the metal apart. Thus each particle has a chance to support its neighbor, the degree of plasticity or flow peculiar to the grade of metal under stress is free to exert itself, stretch takes place all over the sectional area, hence is representative of the true ductility or plasticity of the metal, and fracture finally takes place by a gradual, natural letting go by the particles of each other, by sliding past one another before final and complete separation."

Chronograph Watches.

How many people ever stop to think of the wonderful character of that mechanical marvel which nearly every one carries in his pocket? The ingenuity of pickpockets in removing these machines from the persons of their legitimate owners is, we opine, oftener made the subject of reflection than the science, invention, and mechanical skill embodied in them. A watch (rarely thought of as a machine by the average person) is, perhaps, more wonderful in all its aspects than the steamship or the locomotive. Its accuracy of movement; its durability; the slight attention required by it, though running day and night for a half century or more; its compactness; its usefulness in all departments of human activity,—are qualities which it possesses in greater degree than almost any other product of the human mind and hand.

Engineering (July 3) occupies considerable space in the illustrated description of the mechanism of the modern chronograph watch. We cannot review the technical part of this interesting article, but will simply condense some general remarks indicative of the trend of recent progress in the art of horology.

A steam engine that will run with a variation not exceeding one per cent. is counted perfect, and yet the cheapest nickel-cased watch that exhibited so much divergence from accurate time-keeping would be very properly returned to the seller as useless. The commonest watch should go within (say) 1½ minutes a day, or within $\frac{1}{10}$ per cent. variation, while a good one should not gain or lose more than 10 seconds,—say $\frac{1}{100}$ per cent. variation. Still better results are attained in those cases in which the highest excellence is sought, irrespective of cost. The steam engineer would be proud if he could succeed one hundredth part so well.

Recent advances in horological art have been principally directed to measuring short periods of time with extreme accuracy. There were plenty of good watches in the "fifties," but there were none that could be read to a fraction of a second. Our grandfathers had their stop-watches, in which the mechanism could be held or released by pressing a button on the case, but the time occupied in the operation was an indeterminate quantity, and one observation, either at the beginning or at the end of the period, had to be made while the second hand was moving. The increased interest taken in sport, and the desire to differentiate between results differing only by a fraction of a second, led to the introduction of the "split seconds" chronograph, in which it is possible to read to a fifth of a second, provided, of course, that the observer has no "personal equation," or that it is equal at both ends of the period to be measured. This form of watch is not so recent as to be a novelty, but it involves much ingenious mechanism not generally understood.

The long seconds hand in a chronograph watch does not, of course, move at ordinary times, when the watch is in the pocket. In this respect, and in many others, it differs from the seconds hand of the ordinary stop-watch. If desired, it can be put in permanent engagement with the train, but it is contrary to the intention of the maker to keep it in rotation without a special object.

An explanation of the mechanism by which these results are obtained follows; but we pass this to note what is said of non-magnetizable watches. These are a necessity to all dealing with electric apparatus, and within the last year or two they have received great improvement. The difficulty was to find a material for the hair-spring that was non-magnetic, and yet reliable for time-keeping purposes. An alloy of palladium is now used, and has given so successful results that non-magnetizable watches can now be made to obtain the highest marks for class A certificate at Kew. The test includes submission to a temperature range of from forty deg. to eighty-five deg., to exposure in an intense magnetic field, and to forty-five days' rating in every possible position. When it is remembered that, out of the millions of watches made annually, only some two thousand are thought good enough to face the Kew test, and that out of these only fifteen to twenty per cent. secure the A certificate, it will be understood how excellent these non-magnetizable watches can be made. Last year a gold minute and split seconds chronograph watch with non-magnetizable balance, constructed by Messrs. Smith, obtained, in the temperature tests at Kew, 19.7 marks out of a possible 20; that is, it was almost theoretically perfect. It was selected for special mention in the *Annual Year-Book of the Proceedings of the Royal Society*.

Cast-Iron Grafting.

As a rule, success in casting a mass of iron so that it fuses upon and becomes an integral part of another piece previously cast and placed in the mold has not been so great as to encourage most founders to undertake the job. The secret of the matter appears to lie in the fusing of a portion of the cold piece to a sufficient depth at the place where it meets the new metal; and it seems that the composition of the new metal ought to be the same, at least approximately, as that of the old.

The fusion of the old metal to a sufficient depth requires that the new metal should be of enough larger quantity than the volume of the part to be grafted on to allow its running steadily over the part of the cold metal to be fused for the time required to effect the fusion; that the metal poured to effect the fusion should be hotter than is required for the ordinary casting of the piece to be grafted on; that the mold should be of a character to resist and stand up well under this higher heat; and that provision should be made for the free running off of the superfluous molten metal used to heat the cold part to the fusing point, and also for suddenly stopping this flow when the fusion has proceeded to the desired limit. As a practical economy, it is well also to provide for receiving in ladles the superfluous metal, and using it for filling other molds where a colder metal will answer.

Every one of these practical points is illustrated in the operation of grafting wabblers upon eight-inch train rolls as carried out with entire success by Mr. W. L. Hayden, and described by him in *The Foundry* (July) as follows:

"Everyone familiar with the hard wearing strain that these parts are subject to will be interested in knowing that grafting can be done so as to insure practical results. In the first place, we drill and break off the part which may be left of the wabbler, so that it is almost flush with the journal bearing. The fragment of the wabbler thus having been removed, we chip off this fragment in a thorough manner, so as to remove all rust where the melted iron comes in contact. A pit is then dug in the ground of such depth as to receive one-third of the roller, and is rammed with sand, so as to keep the roller in a perpendicular position. It is best to place a level on the journal bearing, to obviate an uneven pressure when the iron is poured. Having made a pattern of the wabbler and journal bearing, we are able to make a perfect dry sand mold similar to any dry sand core. The outside diameter of the mold should be the same as that of the roll, so that it will stand perpendicularly. We then place the mold over the journal bearing, putting paste and sand where it forms its bearing on the shoulder of the roll. The dry sand mold should have a tap-hole even with the surface of the journal bearing, where the grafting takes place, so that the iron fed from above can escape, after flowing over the iron surface at the bottom. At the top a runner notched through the mold is cut to let the overflow escape in one direction and into a receiving bed below, after the tap hole is plugged. We next take three parts of a round iron flask large enough in size to allow about a three-inch clearance, and slide them down over both the mold and the roll, until it stands about three inches above where the mold and the roll join. The clearance then is filled with sand and rammed, so as to strengthen the mold on the shoulder. We then build up with iron flasks, weights, or anything suitable, until even or almost so with the tap hole, covering the top plate with green sand and forming a runway for the bottom waste to feed into the ladle placed below, to be carried away and used in some mold that the deadness caused by the process does not harm. This saves any waste of iron. Now that things are placed properly to receive the iron, we can proceed, as follows: about three to four bull ladles of cold-blast iron are poured respectively into the top of the mold, tapped directly into the ladle from the cupola, so as to obtain iron of the highest possible heat.

"This iron passes completely over the surface below, and should be continued until the cold iron is melted to about three inches in depth. This can be easily determined by sounding with a small iron rod, and subtracting the difference in depth from the top of the mold at the beginning from the increased depths as the process continues. The amount of iron to be used cannot always be determined, as success is due entirely to bringing the cold iron to a heat of 3,477 degrees F., or over, thereby insuring a perfect and homogeneous combination of old and new iron. These rolls were not rapped out for one day after pouring, so as to allow the iron to anneal somewhat. They were put a week afterwards in their respective places in our rolling mill, and two hundred tons of quarter-inch steel rods were rolled from one and three-eighths billets without a mishap. When taken out, there was no impression whatever from the severe test, and it was noticed particularly that the coupling boxes showed marked signs of the severe work undergone."

The Serpollet System.

THE Serpollet system of propelling horseless carriages appears to have been the most successful system yet exploited. A large number of these cars are said to be running in Paris and its vicinity, and the cost of running, according to *Engineering Mechanics* for July, averages 5½ cents per mile as compared with 9½ cents per mile by systems formerly employed. It is added that many more Serpollet cars are soon to be placed in service.

The key to the mechanical success of this system undoubtedly lies in the very ingenious steam generator employed, in which steam is generated almost instantaneously and with a degree of safety that compares favorably with that of steam boilers of older construction. Small quantities of water are flashed instantaneously into steam, the form of tubes—steel or copper—being that which results from flattening a cylindrical tube until a narrow passage—called "a capillary space"—is formed. "A sufficient number of these flattened tubes placed in a fire-box constituted the generator at first, but at present a sufficient number of steel tubes are assembled in U shapes, ends circular and threaded, connected at ends for free circulation. Only the flattened or capillary portions of the tubes are exposed to the direct action of the fire, the ends and connecting pieces being beyond its action, and therefore subjected to far lower temperature. The tubes are capable of sustaining working pressures beyond 100 atmospheres and in extreme temperatures. Amongst many official trials carried out to test the strength of these elements, the following may be mentioned. One end of the tube was hermetically sealed, and the other was connected to an hydraulic pump. The tube was then placed in a forced fire and raised to a red heat, and was then subjected to a pressure of 200 atmospheres; under this extreme test it was impossible to detect any deformation that could be measured by gage. By a ministerial decree dated October 13, 1888, the Serpollet generators are licensed to work at a pressure of 94 atmospheres.

"Proceeding gradually during the last eight years, the Serpollet generators, at first only made of 2 and 3 horse-power, are now constructed, in large numbers, of 25 horse-power; and, instead of being only able to drive a tricycle weighing 700 pounds, they are largely used for high-speed cars weighing 20 tons. Cars holding six persons are operated at a cost of six cents per mile."

Of course, an active circulation has to be maintained in these flattened tubes. A pump is, for this purpose, driven from an eccentric on the forward axle of the car. A starting pump is placed in the driver's compartment.

The transmission of power from the motor to the driving wheels is by a chain and sprocket attachment, analogous to that so successfully applied to the modern bicycle. The system has proved equally good for tramway cars and carriages run upon the ordinary highways.

The Vibration of Engine Foundations.

In treating this subject Mr. James Whicher (*The Electrical Review*, London, July 17) takes the broad ground that no amount of elaboration of foundations affords a safeguard against vibration, and that this safeguard is to be reached only by a perfect balancing of the engines themselves. In illustration of this proposition, he imagines a single crank unbalanced engine of, say, ten inches stroke, with reciprocating parts weighing five hundred lbs. while engine and foundation block together weigh five hundred times as much. Then, if the whole be considered as floating entirely free in space, like Mahomet's coffin, the oscillations of the piston must, by the elementary laws of dynamics, produce a counter oscillation in the larger mass, the "stroke" or amplitude of which will be 1-500th of ten inches, or .02 inch. If the centre of gravity of the larger mass be not in the line of motion of the smaller, there will be a considerable tilting oscillation also, covering, in fact, an angle equal to that subtended at the C. G. of large mass by the stroke of the C. G. of the small mass; and the direction of the oscillations in space will be changed into the line joining the C. G.'s at the moment of starting from rest.

When the foundation block is firmly imbedded in the ground, its oscillations will be damped, but in what degree it is impossible to surmise. It becomes the source of vibration waves propagated through the earth around, in some respects as sound waves would be, and with the same velocity,—but chiefly as surface waves. Wave motion implies a growing lag of phase of the oscillations of masses, as farther distant from the source. Wherefore, in a perfectly elastic medium, it is a balanced motion, the sum of all the momenta being nil.

It is not deemed safe to trust to the earth to eliminate these vibrations before they reach a point where they may be objectionable. The vibrations are considered almost entirely due to the action of reciprocating parts, and, in balancing these parts, it is necessary to consider, not merely the actual motions, but their resultants. Here the author strikes the keynote of all perfect balancing of moving parts; the action of the counterbalance must be in a direction opposite to that of the resultant of motion of the parts to be balanced,—a fact not well understood by many constructors, who thus place their counterbalances in ineffective positions. In a continuation of the discussion this point is elaborated.

Testing Lubricating Oils.

A CHEAP, simple, and easily-manipulated device for testing lubricating oils was recently presented in *American Machinist* by Mr. W. E. Crane, from which description the following is condensed.

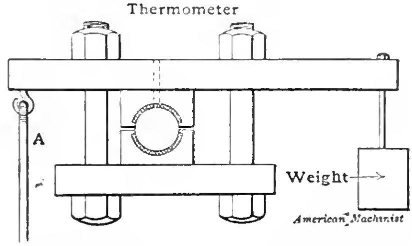
"Get a box at least as long as the diameter of the shaft; have it babbitted, and drill a hole through the top and nearly through the babbitt, so that a thermometer will nearly reach the shaft.

"Put a clamp on the box as shown, having one side long, so as to have a hinged support fastened to the floor on the short end and a weight on the long end. Provide a sight-feed oil-cup so as to feed a certain amount of oil for, say, ten minutes.

"If you have a standard oil, screw the clamp together, adding weight as necessary, until in the ten minutes the temperature will rise twenty-five degrees, or thereabouts."

To test any other oil for lubrication with reference to the standard selected, adjust the feed to the same rate, tighten the clamp till the weight is lifted, and note the rise in temperature.

Of course, there are other qualities de-



FRICTION DEVICE FOR TESTING OILS.

sirable in lubricating oils besides lubricating power,—to wit, their degree of liquidity in cold weather, their behavior when agitated with water in cases where oil and water may get mixed as in some steam engines, and the ease with which the oil may be filtered to render it again fit for use when collected from drips, etc. Mineral oils filter best, and do not form emulsions with water, like animal oils, but they heat up quicker in the testing. Mr. Crane says that, in a mill where the oil is not to be filtered, the oil showing least rise in temperature is best, provided that it feeds well, does not gum, and is sufficiently liquid for use in cold weather.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

The Machine Shop.

7272. Cast Iron Grafting. W. L. Hayden (How wobblers may be grafted on to 8-in. rolls and be made to endure all the wear and strains required. Interesting and instructive description with illustrations). Foundry-July. 500 w.

7351. Machine for Shaping Sprocket Wheels by Broaching (Illustrated description of a machine for broaching all the teeth of a bicycle sprocket wheel at one stroke). Am Mach-July 30. 400 w.

7354. Walker's Magnetic Clutch for Drill Presses (Illustrated description of clutch as applied to a drilling machine). Am Mach-July 30. 400 w.

7421. Points in Shop Management. B. F. Fells (Need of thorough-going, alert mechanics. Shiftless ways in some shops lately seen). Ir Tr Rev-July 30. 1100 w.

7514. Lathe Work Support. John Randol (Illustrated description of a support used in making long screws). Am Mach-Aug 6. 500 w.

*7529. Electric Wheel Welding Machine (Illustrated description of a machine for welding up wheels with metal hubs and spokes). Ind & Ir-July 31. 1000 w.

Steam Engineering.

7035. Operating Engines without a Natural Supply of Condensing Water, or the Continuous Use of Injection Water. E. J. Philip (The leading points as at present practiced). Can Elec News–July. 2000 w.

7048. Smoke Prevention from a Mechanical Standpoint. C. H. Benjamin (Extract from paper read before the Civil Engs.' Club of Cleveland. The essentials of a good smoke preventing device, and causes for failures in mechanical stokers as smoke preventing devices). Safety V–July. 1500 w.

7092. Tests of the Efficiency of an Injector. Karl Andréa (Results and tabulated data obtained from a series of experiments upon a Penberthy injector). Eng News–July 16. 700 w.

7108. Tests of Two Systems of Firing on a Water-Tube Boiler (Records of two tests conducted by George H. Barrus at the Edison Electric Illuminating Co.'s Atlantic Ave. power station, Boston, Mass. which had for an object a comparison of two systems of firing,—the common method of spread firing and a coking system in connection with a brick roof over the front of the furnace. Data show superiority of spread firing). Eng Rec–July 18. 600 w.

†7167. Boiler Inspection (Proposed addition to existing rules, as they relate to shells and riveting). Ind Engng–June 20. 2500 w.

7238. The Coming Boiler (The water-tube boiler is treated as a mechanical necessity, since the safe limit of pressure for the cylindrical boiler has been reached. Abstract of address by G. B. Hartley, before the Boilermakers' Assn.) Min & Sci Pr–July 18. 600 w.

*7275. The Vibration of Engine Foundations. James Whitcher (The proposition toward which the argument is directed is that elaboration of foundations affords no security against injurious vibrations, which can only be obtained by perfect balancing of the engine plant). Elec Rev, Lond–July 17. Serial. 1st part. 1400 w.

*7290. The Evaporative Condenser for Steam Engines (The first part contains general remarks and illustrated description of appliances). Mach, Lond–July 15. Serial. 1st part. 2000 w.

*7295. The Commercial Efficiency of Steam Boilers. A. Hanssen (Read before the Civil and Mechanical Engs. Soc. The author utilizes material supplied during the past ten or fifteen years of experimental investigation, particularly that derived from experiments of Donkin, Kennedy, Unwin, Kestner and Déry,—for the determination of a form of boiler that will produce steam most cheaply, and to arrive at conclusions as to the extent to which cheap steam production must be sacrificed to other considerations). Engng–July 17. 3200 w.

7352. Snap Piston Rings. F. A. Halsey (Directions for fitting, with diagrams). Am Mach–July 30. 1200 w.

7406. Fly Wheels for Steam Engines. E. F. Williams (Discussion of the proper proportion of wheels under certain specified conditions, with rules for their construction and performance). Elec Engng–Aug. 3000 w.

7426. New Vertical Cross Compound Engine at Whitman Mills, New Bedford, Mass. (Illustrated detailed description). Power–Aug. 1400 w.

*7432. On Smokeless Combustion and Boiler-Firing. W. Hempel (Abstract from *Stahl und Eisen*. The author combats the statement commonly made in text books that the two compounds, carbon monoxid and carbon dioxid, result in combustion according to the quantity of air supplied to the fuel, and holds that the character of the products depends also upon conditions of temperature and pressure). Col Guard–July 24. 700 w.

7513. Quick-Opening Throttle Valves. Peter H. Bullock (The author believes that while, as a rule, throttle valves should be operated slowly, provision for operating them quickly ought also to be provided for use in cases of emergency. He illustrates and describes means for doing this, of his own devising). Am Mach–Aug 6. 700 w.

7515. Some Features about the Belgium Engines of H. Bollinckx. John E. Sweet (Illustrated description, with comments upon the system of active steam jackets, which is a feature of these engines). Am Mach–Aug 6. 1300 w.

Miscellany.

*7009. Chronograph Watches (Recent advances in the horological art. Measuring short periods of time with extreme accuracy). Engng –July 3. 2200 w.

*7044. The Duty of Pumping Engines. Dugald Baird (Read before the Mining. Inst of Scotland. Easy method of finding duty, with a few examples). Can Min Rev–June. 3500 w.

†7053. The Air Lift Pump. C. C. Stowell (Deals with the early history of raising water by air lift, its general principles, and with an installment, at Rockford, Ill., with illustrations and discussion). Ill Soc of Engs & Surv–11 An Rept. 2800 w.

†7054. The Hydraulic Ram for use in Public Water Works Systems. Daniel W. Mead (The author thinks this machine is less perfectly understood than almost any device that has been so long before the public, and this paper is an explanation of its principle and action and illustrates and describes existing forms. Discussion). Ill Soc of Engs & Surv–11 An Rept. 4500 w.

7094. New Foundry of the Niles Tool Works, Hamilton, O. (Illustrated description). Eng News–July 16. 600 w.

†7201. The Theoretical and Measured Pumping Power of Windmills. E. C. Murphy (A contribution of data and formulæ to the art of constructing and operating windmills). Am Soc of Ir Engs–April, 1895. 3500 w.

7203. About Test Sections. P. Kreuzpointner (An argument in favor of using as large size test pieces of metal as is practicable). Ir Age–July 23. 2200 w.

7214. Pneumatic Power in Workshops. John Davis Barnett (A paper read before the Canadian Soc of Civ. Engs., Toronto. Qualitative rather than quantitative results are dealt with; the author stating that reliable data for quantitative results are, in his opinion, not at present obtainable. Discussion). Can Eng–July. 6000 w.

7215. The Power of the Future. Thomas Frood (Steam is considered as having had its day. Gas and electricity are now contending for supremacy and at present the author believes gas has the lead, but he thinks electricity will win in the long run). Can Eng–July. 1500 w.

7216. A Question in Mechanical Design. R. W. King (The question discussed relates to screw threads of bicycle pedals. Which side of the bicycle should be the pedal with the left hand thread?). Can Eng–July. 1000 w.

7227. The Bicycle (Illustrated history, beginning with the tandem wheeled hobby-horse of the last century). Sci Am–July 25. 1800 w.

7229. The Sewing Machine (History from the date of allowance of Elias Howe's application for U. S. letters patent, in 1846, to the present time. Illustrations of the earlier machines). Sci Am–July 25. 3000 w.

7230. Agricultural Machinery (History of reaping machines). Sci Am–July 25. 4200 w.

7232. Fifty Years in the Printing Business (Illustrated historical sketch). Sci Am–July 25. 1700 w.

7273. How to Gain a Knowledge of the Nature of Cast Iron (Plain pointers upon practical iron founding, in the form of questions and answers). Foundry–July. Serial. 1st part. 1800 w.

*7279. Machinery Bearings. John Dewrance (The results of a series of experiments undertaken by the author to determine the frictional resistance to shafts revolving in bearings under varying loads when subjected to different conditions). Ind & Ir–July 17. 3800 w.

*7280. Gas Engines as Economical Motors. J. Holliday (The first part contains general remarks; discusses the advantages of subdivisions; comparison of systems. etc). Prac Eng–July 17. Serial. 1st part. 2000 w.

*7294. The Training of Apprentices (The system in use in the French railway workshops. The idea is to educate the apprentice in theory, simultaneously with his manual training). Engng–July 17. 1100 w.

7346. The Making of a Band Saw (Illustrated description). Ir Age–July 30. 2000 w.

7348. The Repair of Single Tube Bicycle Tires (Several methods of repair are described, with numerous illustrations). Sci Am–Aug. 1. 2000 w.

7355. Uses and Advantages of a Public Supply of Compressed Air. Frank Richards (Explanation of a way whereby water motors may be used in connection with a supply of compressed air). Am Mach–July 30. 1200 w.

7364. A Steel Framed Wheel 100 ft. in Diameter (Illustrated detailed description). Eng News–July 30. 400 w.

7366. The Evils of Fictitious Accuracy (A severe editorial criticism of methods adopted by some engineers, which assume to give greater accuracy in statement of results than the limits of error will justify, or that can be practically useful). Eng News–July 30. 1600 w.

*7387. A Water Power and Compressed Air Transmission Plant for the North Star Mining Company. Grass Valley, Cal. Arthur De Wint Foote (Abstract of paper read before the Am. Soc. of Civ. Engs. General description). Am Eng & R R Jour–Aug. 2200 w.

†7389. Sharp's Shaft Coupling (Coupling invented and designed by Prof. Archibald Sharp of Central Technical College, South Kensington, Eng). Ind & East Eng–July 4. 800 w.

7417. The Introduction of Oil in Bearings (An experimental research). Eng Rec–Aug 1. 1100 w.

7428. Where Shall We Locate the Power Plant? C. C. Dennis (An estimate of cost as affected by location, collaterally touching upon the necessity for steam heating, as an element to be considered in the answer to the question). Sta Eng–Aug. 1400 w.

7484. Testing Machine of 200,000 lbs. Capacity for the University of New York (Illustrated description). Eng News–Aug 6. 500 w.

7485. Heating a Cotton Mill from the Hot Well of a Condensing Engine (Extract from paper by George W. Weeks, read before the New England Cotton Mfrs. Assn. and printed in the *Providence Journal*. Brief description of a blower system for heating and ventilating in which the pipes of the heater are filled with water from the hot well of the condensing engine instead of with steam). Eng News–Aug 6. 2000 w.

*7496. The Manufacture of Power (Editorial reviewing the benefits to mankind due to the discovery of the means to manufacture unlimited power. The intellectual progress of the race not only became possible but a necessity). Engng–July 31. 2800 w.

*7511. Air Compressors. Philip R. Björling (Describes the different types of air compressors, giving illustrations, and states facts regarding their efficiency). Col Guard–July 31. Serial. 1st part. 2000 w.

*7518. Chains and Chain Iron. G. N. Shawcross (Qualities of iron suitable for chains; different kinds of chains; tests for determining quality and the commencement of an illustrated description of processes for manufacturing chains, are the topics presented in part first). Prac Eng–July 31. Serial. 1st part. 3500 w.

*7527. Notes on the Introduction and Development of Rope Driving. Abram Combe (Notes, chiefly historical). Ind & Ir–July 31. 2000 w.

*7552. Flax Scutching and Flax Hackling Machinery. John Horner (Read before the Inst. of Mech. Engs., at Belfast. Illustrated description of machines and processes). Eng, Lond–July 31. 2500 w.

†7561. Aerial Tramways. W. R. Shaw (General considerations relating to rope conveyors, and a list of some of the most interesting lines). Ind & East Eng–July 11. 2200 w.

MINING & METALLURGY

The Influence of Metalloids in Cast Iron.

THE Western Foundrymen's Association, following the suggestions of a paper by Major Malcolm McDowell reported in *The Iron Age*, has undertaken a work of striking significance and of almost overwhelming extent. It is, briefly, the actual determination, by an exhaustive series of metallurgical, chemical, and physical tests of the exact influence of all the usual minor constituents,—carbon, manganese, silicon, phosphorus, and sulphur,— not only separately, but in the widest range of varying proportion in combinations of two or more.

At present, as Major McDowell states, the whole subject of grading pig is in the most unsatisfactory and nebulous condition. The supposedly corresponding grade numbers of northern and southern furnaces do not agree, nor is there "a reliable similarity in the corresponding numbers of different furnaces in either section," even though these numbers are supposed to be based on the simple mechanical test of fracture. When it comes to a consideration of actual composition and suitability for different classes of castings, the trade is still further at sea.

Nearly every foundryman has at times made an exceptional metal, but how he did it he does not know, nor has he ever since been able to reproduce it. Others have, by experimenting with different brands of pig iron, produced an exceptional metal, and, as long as they were sure of the same pig, they duplicated it. But what special metalloids acted in combination with the iron they were unable to tell.

That such a state of things is eminently unsatisfactory goes without saying.

The furnaceman and the foundryman are alike interested in knowing the value of each constituent element composing the pig that is made by one and used by the other,—not so much a scientific expression of their value, but a practical demonstration that will enable the one to formulate a specification of his wants that the other may meet the requirements with as much ease and precision as he does the wants of the chemist of the steel maker. As a general thing, the foundryman does not know the chemical constituents of a metal that will make a casting for a special purpose. He buys a metal from the furnaceman that the one thinks and the other hopes will make what they want; neither are certain, both are guessing, each holding the other responsible if it fails, both claiming the honor if it succeeds.

It is to be assumed without question that the furnaceman is just as desirous as the foundryman to reach a more satisfactory and certain knowledge, but facts are not at hand.

There is more or less information scientifically expressed of the nature and relations existing between iron and carbon and the various influences exerted on them by the four different metalloids,—silicon, phosphorus, manganese, and sulphur. This information is not put in so practical a form as to designate the value of these elements in making up a specification for certain grades of metal.

However, there are already indications of the inception of a new order of things. Out of all this anxiety from "guessing" is evolving a new condition. Here and there foundrymen are adding laboratories to their equipment, and the chemists are learning the value of certain metalloids in making special castings.

To confirm and expedite the new era, Major McDowell suggests joint action in carrying on the experiments. "Knowing the great value," he says, "of a knowledge of the relations which exist between different metalloids and iron in making castings, I think it would be advisable to make a series of experiments to determine these relations and their relative values. I would use a cupola that would melt 1,000 pounds an hour, taking 250 pounds on the bed, tapping the latter amount into a ladle of that capacity, from which I will take the tests necessary. Charcoal should be used as fuel, until the desired metal is found, and then coke or anthracite coal used to determine their effect on the standard."

Under these conditions heats would be made, "keeping all but one of the variables constant, and increasing one metalloid." The first series would be with iron, carbon, and varying silicon; in the next, manganese would be substituted for silicon, the third and fourth would be with both manganese and silicon, first one and then the other being varied. Then phosphorus will be introduced. With the entire series completed and tabulated, there will be demonstrated, as Major McDowell thinks, the effects of the metalloids and their combinations upon the physical, chemical, and metallurgical tests, determining the practical value of each or of a combination of the metalloids in making cast iron in a cupola. The importance of the work suggested appealed at once to the Association, and a committee of three was authorized to carry on the tests and experiments under the direction of the board of directors of the Western Foundry-Men's Association.

The undertaking is stupendous. As *The Iron Age* remarks editorially, "the work, if done exhaustively (and to be valuable it cannot be done otherwise), will certainly extend over several years, requiring patient industry and unselfish devotion" by the members of the committee. It is greatly to be hoped that the work will receive, as it deserves, the suggested assistance and coöperation of the technical schools. They could hardly undertake anything in their laboratories more instructive to the students or more helpful to the iron industries.

Non-homogeneous Alloys of Gold.

AN article by Edward Matthey "On the Liquation of Certain Alloys of Gold, appearing in a recent number of *Nature*, abridged from a paper before the Royal Society, gives some curious and interesting information on the apparent extreme difficulty of securing a homogeneous composition for certain alloys of gold with the baser metals. The subject is described as being invested with considerable practical importance though the new extracting processes which are sending to England, from South Africa especially, "a series of alloys of gold and of the base metals that have hitherto rarely been used in metallurgical industry."

To illustrate the difficulty, Mr. Matthey gives the results of a number of assays of a typical ingot. Four determinations made on a portion of metal cut from an upper corner varied from 465 parts of gold per 1,000 parts to 664 parts per 1,000.

Three assays made of a piece from the bottom of the same ingot gave 652 parts of gold per 1,000 as the highest result, and 332.5 as the lowest.

Evidently, gravity was not the causative agent in the matter, or the gold would have been in larger proportion at the bottom. Still more evidently, there was nothing like uniformity of composition anywhere in the mass.

The whole ingot was then brought into fusion, and small "dip" samples were taken from the thoroughly-stirred molten mass; but these again gave results varying from 562.3 to 653.5, showing that "rearrangement (on cooling) could take place within the limits of a fragment of metal which did not weigh more than a few grams."

Separation of the metals was finally made in mass, showing the actual value of the ingot to be £1,028, while an average of all results would have fixed it at £965,—a very large error.

The actual analysis proved to be:

Gold	61.7
Silver	8.1
Lead	16.4
Zinc	9.5
Copper	4.0
Iron	.3
	100.0

"Suspicion at once fell on lead and zinc as disturbing elements," and a long series of experiments showed that lead exerts a much greater disturbing influence than zinc. More interesting still was the attack on the problem along the line "of Roberts-Austen's method of fixing the solidifying points of metals on 'cooling-curves' obtained by the aid of thermojunctions connected with autographic recorders. Such curves showed that a triple alloy of lead, gold, and zinc has three 'freezing-points.' The mass sets, as a whole, at a single main point of solidification, but the lead and the zinc associated with some gold retain a certain amount of individual independence, and, by falling out of solution, separately destroy the uniformity of the mass, even though the mass itself be small."

"After a long series of experiments, a metallic solvent was sought which would enter into union with the gold, the zinc, and the lead. Silver proved to be such a solvent,—and solidified alloys of gold, containing not more than thirty per cent. of lead and zinc, may be made practically uniform in composition by adding fifteen per cent. of silver to the mass when fluid."

The diagrams, however, which are appended to illustrate the multiple determinations made on spherical ingots of varying compositions, do not at all bear out this general statement. Fig. 12, which is "alloyed so as to contain fifteen per cent of silver," and therefore should be practically uniform, gives thirteen results, varying all the way from 533.8 to to 595, which seems like anything but uniformity, although it is again specially cited as showing how greatly the arrangements of the alloy has been modified by the presence of the silver.

It is true, however, that it is greatly better than the preceding sample, containing only seven per cent. of silver, which varied from 413.8 to 707.2; but this in turn is far worse than the alloy of 75 parts gold, 15 parts lead, and 10 parts zinc, without any silver at all, which, in five determinations, varied only from 650.7 to 790.8.

On the other hand, zinc alone does not seem to show the disturbing influence attributed to it. An alloy of 95 parts gold and 5 parts zinc gives twelve determinations all lying between 942.7 and 945, and one of 90 parts gold and 10 parts zinc gives twelve results between 899 and 901.5. But both of these results are cited by the author as showing a "decided tendency of liquation of gold toward the center."

Probably, with the full text and complete series of illustrations, the graphic representations would appear more consistent with the statements of the paper. As it is, the figures seem hardly to enforce Mr. Matthey's very interesting investigations and conclusions.

Increased Blast-Furnace Output.

THE age of intensified production has made its influence felt in the iron industry. Not many years ago a furnace making a hundred tons a day, or, at the outside, a hundred and twenty-five tons, was considered a very large producer; about three years since, *Mineral Industry* commented upon the increased output resulting from better ore-treatment and improved practice generally, and reported that Alabama furnaces formerly rated at ninety tons a day were now making one hundred and fifty.

Recent English practice, judging from an address by Mr. E. Windsor Richards before the Institution of Mechanical Engineers, abstracted by *The Iron Age*, makes even these figures seem small. Two hundred tons per day seems to be the readily realizable expectation for a furnace seventy-five feet high with a twenty-foot bosh and a ten-foot hearth, working on a 50 per cent. ore, and twelve hundred tons a week is apparently the ordinary working average for such a furnace.

There seems to be a tendency toward a reversion to a flatter bosh; some details of the abstract are interesting in this connection:

"At Jarrow-on-Tyne a blast-furnace plant was constructed with all recent improvements, from which greatly improved results were expected. As these results were not at first realized, it is of value to ascertain the causes, in order to avoid similar failure in future. The furnace, No. 5, is 75 feet high, bosh 20 feet diameter, having several cooling plates, angle of bosh 80 degrees; hearth, 11 feet diameter; throat, 16 feet; bell, 11 feet; capacity of furnace, 14,150 cubic feet; eight gun-metal tuyeres, 5½ inches diameter, placed 6 feet above the hearth level. Blast of 3¼ pounds pressure per square inch, heated by four Cowper stoves, 73 feet high and 22 feet diameter, to a temperature of from 1,400 to 1,500 degrees F. Durham coke with 8 per cent. ash and 1 per cent. sulphur, 19½ hundredweight per ton of bessemer pig iron. Production 1,000 tons per week from Bilbao and African ores averaging 50 per cent. of iron, increased to 1,100 tons during the last few weeks. Limestone, 8 hundredweight per ton of pig. One pair of compound condensing vertical blast engines, high-pressure cylinder 54 inches diameter, low-pressure cylinder 72 inches diameter, air cylinders 100 inches diameter, stroke 5 feet, making 17 revolutions per minute for 1,000 tons of iron per week. From such an installation as this it would be expected that a large production would be readily obtained at a low cost; but the furnace worked with great irregularity and was continually hanging and slipping. Increased blast pressures were tried, and failed to produce any improved results. The cause was evidently traceable to the steep boshes. So unsatisfactory and costly was the working that the furnace was blown out in June, 1893, and the boshes were altered to 68 degrees. Since this alteration, the furnace has worked well and economically. The engineering portion of the whole plant is well carried out, For a furnace having such a large reserve of blast and heating power, an output of only 1,100 tons per week cannot be considered a good return for the large amount of money expended.

"In a paper read and discussed at the Middlesborough meeting of this institution in August, 1893, our past president, Jeremiah Head, described a blast furnace of peculiar internal form, designed by Howson & Hawdon of Middlesborough. On visiting last month the works of Sir Bernhard Samuelson & Co. in order to ascertain what success this new form of furnace had attained, I found there are five now in operation, giving such satisfactory results that a sixth is being prepared. Two of the furnaces were making Cleveland iron and three hematite. No. 5 furnace with 18 feet bosh, 70 degrees angle, 11 feet hearth, 84 feet high, had made during the previous ten weeks, with Rubio ore containing 50 per cent. of iron, an average of 1,053 tons per week of good gray bessemer iron with a consumption of 18.1 hundredweight of coke per ton of iron, the coke containing 10 per cent. of ash. The blast is supplied by ordinary vertical compound condensing quick-running engines at about 4½ pounds pressure per square inch, and is heated by Cowper stoves to 1,400 or 1,500 degrees F. By increasing the volume and maintaining the heat of the blast Mr. Hawdon expects shortly to attain 1,200 tons per week.

"The Dowlais Cardiff new blast-furnace plant is remarkable for efficient and economical working. The two furnaces have 20-feet boshes, 10-feet hearths, are 75 feet high, and from Bilbao ores containing 50 per cent. of iron each furnace produces 1,250 tons per week of good gray bessemer iron with a little over 19 hundredweight of coke per ton. The production can be readily increased, should the state of trade require it."

American Mines and British Investors.

WE have heard a good deal of complaint and criticism of American investments by British investors, much of it no doubt well-founded, based upon conditions which every sound business judgment must deplore, and which, we hope, criticism and suggestion may aid us to improve.

But the dissatisfaction which has perhaps too often attended the investment of British capital in enterprises in this country is something for which Americans are not always and altogether to blame. Faulty judgment in placing the money, and unwise operations following, have had their contributing influence, and for these our English cousins must accept the blame.

Mr. Thomas Tonge, whose interesting article on the new gold fields of Colorado appears elsewhere in this number, in a letter to *The Mining Journal, Railway and Commercial Gazette*, seems to divide very fairly the burden of responsibility for many of the disappointments realized in mining investments. He says:

"Many mining enterprises, good and sound in themselves, placed in England, have proved financial failures to the shareholders by reason of the following:

"1. Over-capitalization. For instance, a property for which the vender receives (say) £20,000, being more than worth every shilling of it, is floated on the British market at (say) £50,000 or £75,000, or even more, with the result that, whereas the property would have paid handsome dividends on a capital of £30,000, no management can make it pay satisfactory dividends on the exaggerated sum at which it is floated.

"2. Exorbitant 'rake off' by promoters and middlemen, which inevitably is at the expense of the duped shareholder. Too many promoters are not content with a fair remuneration for their trouble, but look for big profits from unloading stock and not from ore shipments.

"3. Excessive office and directors' expenses at the English headquarters, even though involving the curtailing of necessary expenses at the mine. The wealthiest and most experienced and successful mining men in Colorado do not waste their time on public stock companies with the minimum of efficiency and the maximum of red tape formality and office expense, but form themselves into small private syndicates or companies, the capital being furnished by themselves and a few personal friends, and the money put into efficient work on the properties.

"4. Inexperienced and incompetent mining engineers, managers, &c., usually relatives or connections of the directors, sent out to report upon or manage, or in some way draw a salary at, the mine. There are in Colorado considerably over a dozen mining engineers and experts, both British and American, of many years' local experience and unblemished reputation, who must of necessity be more competent to pass opinions on the merits of a mining property in Colorado than any man sent from England to Colorado, possibly for the first time, and at best only an occasional and transient visitor. British capitalists would do well to utilize to a much greater extent Colorado mining engineers and experts, and, judging by past experience, would save large sums of money by so doing, not merely in the travelling expenses from England, but in the better and more reliable advice they would frequently get. Moreover, Colorado mines should not be utilized as eleemosynary institutions for younger sons and failures from England."

Mr. Tonge's last point is especially well taken. It is not unnatural for a foreigner to turn instinctively for advice to an expert of his own nationality, but in the great majority of cases he would do vastly better to consult a reputable American engineer, whose entire education, both direct and indirect, has familiarized him, not only with the obvious elements of the case, but also with the less evident conditions involved in the problem of success.

The Mining of Talc.

THE COLLIERY GUARDIAN gives some interesting notes, abstracted by the Institution of Civil Engineers from a paper by P. Pillez in *Comptes Rendus de la Société de l'Industrie Minérale*, 1895, on the "talc quarries of Luzenac."

The abstract gives valuable information regarding a minor-mineral about which but little is generally known, especially in proportion to its exclusive use. We give the abstract in full:

"At Luzenac, in the upper valley of the Ariège, talc is quarried on an extensive scale in the granite of Saint Barthélemy, a mountain 7,700 feet high, and about 20 miles from the main chain of the Pyrenees. The quarries, which are situated about two miles from the summit, and 5,900 feet above the sea, are opened in a bedded deposit, included between mica-schist below and lower silurian slates above, which has been followed for about 2,000 yards in a north-south direction, with a dip of about 60 degrees to the east, the thickness varying from 160 to 1,000 feet, as does also the composition. Masses of limestone and granite, the latter often of considerable size, are frequently found included in the silicate of magnesia, which also contains some alumina, as shown in the following analysis A, while B gives the composition of the talc of the valley of Pignerolles, in Italy, which has a high reputation for quality.

	A.	B.
Silica	61.85	60.60
Magnesia	34.52	35 30
Alumina	2.61	0.30
Ferric oxid	0.25	0.60
Lime	Trace	0.40
Combined water	0 60	Not determined
Alkalies and loss	0.17	2.80

"The best rock is of a brilliant white color, and feels greasy to the touch when ground to fine powder. The principal quarry, at Tremouin, is worked in the open, across the direction of the bed, forming two or three terraces, 50 feet high, the surface covering, 6 to 10 feet thick, having been first stripped. The stuff broken is carried by a level, in the bottom of the quarry, driven in the foot-wall of the vein, to the valley of Axiat, whence it is hauled in bullock wagons about 12 miles to the works at Luzenac, where a water-power of 90 h.p. is obtained from the Ariège. The mechanical preparation includes sizing by sieves, drying in a rotating-cylinder furnace, breaking, grinding, and sifting. The grinding is done in ball-mills, which rarely require to be stopped for repairs. Nearly the whole of the product is converted into powder, only a small part being made into pencils for marking out work on metal or sold in the lump form. The consumption extends to almost all parts of Europe and America. The principal applications are in soap-making and perfumery, paper-making and weaving. It also forms an ingredient in wagon grease, and is used as an insulator for electric conductors. A new preparation called cupro-steatite, made by mixing talc and sulphate of copper, is now being tried with success as an insecticide in vineyards."

THE Australian *Mining Standard* chronicles the completion of an eleven hundred foot ventilating tunnel in the Great Southern tin mine, Toora, South Gippsland. The mine itself "promises to be highly remunerative, and bids fair to remove the prejudice that Victoria is not a tin producing country.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Mining and Engineering Journals—See Introductory.

Metallurgy.

*6983. Are the Cyanid Patents Invalid? J. S. C. Wells (Contending that the processes of dissolving gold in cyanid and of precipitating it by zinc are public property). Eng Mag-Aug. 3700 w.

6989.—75 cts. Melting Points of Aluminum, Silver, Gold, Copper, and Platinum. S. W. Holman with R. R. Lawrence and L. Barr (Presented at meeting of the Amer. Acad. of Arts and Sciences. The melting points are offered as provisional only, but with the belief that they are more reliable than previous data. Methods and apparatus are illustrated and described). Tech Quar-March. 4800 w.

7077. The Iron Industry of Southern Russia (From report of M. Trasenster, printed in the *Revue Universelle des Mines*. Treats of the ore deposits and iron and steel works). Ir Age-July 16. 3800 w.

*7110. Blast Furnaces, Past and Present (Part first reviews briefly the past history of this industry). Ir & St Trds Jour- July 4. 1600 w.

*7137. American Blast Furnace Practice. Jno. L. Stevenson (The first paper gives particulars, with drawings, of a blast furnace plant for a minimum nominal make of 200 tons per day of twenty-four hours, per furnace, from ores containing 50% of iron for which the furnaces were designed. Specifications of a plant of two furnaces built in the United States). Eng, Lond -July 10. Serial. 1st part. 3000 w.

7154. Steel Making at Birmingham. P. G. Shook (Extract from paper read before the Alabama Industrial and Scientific Society. Relates to the availability of raw material required for basic open hearth steel manufacture in Alabama). Ir Tr Rev-July 16. 1300 w.

7202. Practical Value of the Various Metalloids in Cast Iron. Malcolm McDowell, with Editorial (Results of researches and experiments, followed by brief discussion). Ir Age-July 23. 4500 w.

7252. Concentration of Low-Grade Iron Ores. William B. Phillips (An account of difficulties encountered with this class of material, experiments and investigations. A future article will give an account of experiments with the Wetherill concentrating process). Eng & Min Jour-July 25. Serial. 1st part. 1200 w.

7253. Matte Smelting in California. Herbert Lang (Description of the smelting works at Keswick, Cal). Eng & Min Jour-July 25. Serial. 1st part. 3000 w.

*7297. On the Liquation of Certain Alloys of Gold. Edward Matthey (Abridged from a paper read before the Royal Society. Calls attention to very irregular distribution of the metals in alloys of gold, zinc and lead, and suggests addition of silver to secure homogeneity). Nature–July 16. 1000 w.

†7325. Middle-Product Jig. E. G. Tuttle (Illustrated description of a jig arranged for separating the middle product or middlings obtained in the concentration of certain ores, minerals, coal, etc., with adjustable and automatic discharges for the middle and lower products). Trans Am Inst of Min Engs–July. 1700 w.

†7326. Eccentric Jig, with Adjustable and Automatic Lower Discharge Arranged for the Full Width of the Bed and for One or More Compartments. Edgar G. Tuttle (Illustrated description). Trans Am Inst of Min Engs–July. 1800 w.

†7327. A Mechanical Coke-Drawer. Robert A. Cook (Illustrated description of a device by which the coke from bee-hive ovens is extracted with a minimum of manual labor). Trans Am Inst of Min Engs–July. 1000 w.

†7328. The Newton-Chambers System of Saving the By-Products of Coke-Manufacture in Bee-Hive Ovens. Robert A. Cook (A brief history of the development at Sheffield, Eng., of a most successful system of the utilization of by-products in connection with an already existing plant of bee-hive ovens). Trans Am Inst of Min Engs–July. 1200 w.

†7332. The Sulphuric Acid Process of Treating Lixiviation Sulphides. Frederic P. Dewey (Description of the Dewey-Walter process and its application, with its advantages). Trans Am Inst of Min Engs–July. 7500 w.

†7333. Action of Blast Furnace Gases Upon Various Iron Ores. O. O. Laudig (Experiments made in the laboratory of the Buffalo Furnace Co). Trans Am Inst of Min Engs–July. 2700 w.

†7336. Notes on the Walrand-Legénisel Steel-Casting Process. H. L. Hollis (Brief statement of process with some recent changes in practice). Trans Am Inst of Min Engs–July. 1700 w.

†7337. The Cycle of the Plunger-Jig (Communications in discussion of the paper of Prof. Robert H. Richards, Boston, Mass., presented at the Pittsburg meeting, Feb., 1896). Trans Am Inst of Min Engs–July. 1800 w.

†7338. The Accumulation of Amalgam on Copper Plates (Communications in discussion of the paper of Mr. R. L. Bayliss, presented at the Pittsburg meeting, Feb., 1896). Trans Am Inst of Min Engs–July. 3500 w.

†7339. The Physics of Cast Iron (Continued discussion). Trans Am Inst of Min Engs–July. 7500 w.

†7404. The Conditions which Cause Wrought Iron to Be Fibrous and Steel Low in Carbon to Be Crystalline. W. F. Durfee (Observations and conclusions derived from practical acquaintance with the manufacture and employment of iron and steel. Contributive to a correct understanding of the structural relations or as indicative of their proper treatment). Jour Fr Inst–Aug. 13000 w.

*7431. The Preparation of Chemically Pure Iron. W A. McGillivray (From Journal of West of Scotland Iron and Steel Inst. Investigation carried out on the suggestion and under the supervision of the late Prof. William Dittmar). Ind & Ir–July 24. 3000 w.

7435. Standard Specifications for Structural Steel (Specifications are given in full as adopted by the Assn. of Am. Steel Mfrs). Eng & Min Jour–Aug 1. 1500 w.

*7479. An Improved Process of Extracting Gold Ores (Describes the process patented and perfected by J. W. Bailey, of Denver, Col., and the experimental plant in operation at Cripple Creek). Aust Min Stand–July 2. 1500 w.

*7497. The Action of Blast in Cupolas. Thomas D. West (Paper read before the Western Foundrymen's Assn., Chicago. Power of blast penetration and improvements in center blast). Engng–July 31. 2700 w.

*7530. Description of the Alumina Factory at Larne Harbor. James Sutherland (Read at the Belfast Meeting of the Inst. of Mech. Engs. Detailed description). Ind & Ir–July 31. 2400 w.

*7551. The Iron and Steel Works of the United States (Items taken from the introduction to the "Directory of Iron and Steel Works." respecting the development and present numbers of works and manufacturing plants in these industries). Eng, Lond–July 13. 1600 w.

Mining.

6996. Quartz and Placer Deposits in British Guiana. Charles E. Clarke (Description of the country generally and of the Barima district in particular). Eng & Min Jour–July 11. 2400 w.

6997. The Broken Hill Silver Mines in Australia (An account of the silver production region of New South Wales. Some statements taken from the Melbourne *Argus*, the figures being supplemented and corrected by the companies). Eng & Min Jour–July 11. 2000 w.

*7017. On Gold Mining in Rhodesia, British South Africa. William Fischer Wilkinson (Experiences of the writer during a visit of two months duration, at the latter end of 1895. The best way of reaching the country, the geographical position of the gold fields, a list of the principal fields with the names of some of the prominent mines, the geology, mining laws of the country, and evidence of past workings, are some of the subjects receiving attention). Jour Soc of Arts–July 3. 4400 w.

*7045. Notes on the Eustis Mine, Que. Raoul Green (Paper awarded prize of $25, being first in a series of students' competitive papers read before the Gen. Min. Assn. of Quebec. It is the result of careful observation while working in this mine). Can Min Rev–June. 2500 w.

*7046. The Lighting of Collieries by Electricity (The value of electricity for this purpose, the conditions of underground lighting, the difficulties and suggestions, with some examples). Can Min Rev–June. 2500 w.

7128. Trail Creek. David B. Bogle (The progress and extensive development of this camp). Eng & Min Jour–July 18. 1100 w.

*7157. Telluride, Colorado. T. P. Van Wagenen (The first part consists largely of a description of the country, the formation and location of the mines). Min Jour–July 11. 1700 w.

7205. St Elmo and Chaffee County (Illustrated description and general information regarding these mines). Min Ind & Rev–July 16. 3500 w.

7254. "La Brilladora" Mine, Jalisco, Mexico. James L. Buskett (Illustrated description). Eng & Min Jour–July 25. 600 w.

*7256. The Kent Coalfield. F. Brady, G. P. Simpson, and N. R. Griffith (From the results of the investigations made it appears that there is enough coal to supply 30,000,000 tons per annum for the next 100 yrs). Coal Guard–July 17. 1100 w.

*7300. Coal Mining Puzzles (The present position of the coal trade of Great Britain, and the causes. Editorial). Eng, Lond–July 17. 1400 w.

*7303. Gold in Western Australia. Charles J. Alford (Conditions of deposition, characteristics, process of working, veins, surface deposits, and other related topics are treated briefly). Min Jour–July 18. 2500 w.

*7304. Mining in Asturias (Spain).—The Cinnabar Zone (Description of work in this most important of the coal fields of Spain). Min Jour–July 18. 1100 w.

*7305. Notes on the Cost of Mining and Earthwork in Asia Minor, Persia, and Burmah. T. Trafford Wynne (Statistics of the cost of labor in various mining operations in countries not often visited). Min Jour–July 18. 1600 w.

†7334. Coal Dust as an Explosive Agent. Donald M. D. Stuart (Reply to criticisms made in discussion of the theory advanced by the writer, with further statement of his views formed from further investigations). Trans Am Inst of MinEngs–July. 9500 w.

†7335. Copper Ores in the Peronian of Texas. E. J. Schmitz (Report of the territory examined, description of ore, and its deposition). Trans Am Inst of Min Engs–July. 2800 w.

7362. The Gold Belt of Gunnison County, Colorado. Thomas Tonge (Information obtained personally by the writer during two visits, examining the mines and prospects of the belts, which is about 65 miles long and 15 miles wide). Min & Sci Pr–July 25. 1500 w.

*7376. The Cripple Creek Goldfield (Descriptive of the country, and reviewing the changes of the past five years). Aust Min Stand–June 11. 2000 w.

*7377. The Zeehan-Dundas (Tas.) Mineral Fields (Extract from report of the Tasmanian mines inspector. Information as to some of the geological features, with correction of statement previously made regarding concentration losses). Aust Min Stand–June 11. 1800 w.

*7384. The Trail Creek District, B. C. (Full illustrated description of these rich mines). Can Min Rev–July. 10000 w.

7436. Angels Camp, California, and Vicinity. H. L. Tyler (Account of the mines of these districts, with maps). Eng & Min Jour–Aug. 1. 1400 w.

7437. Mineral Regions of British Columbia. H. M. Beadle (Illustrated description of the country within a few miles of Rossland). Eng & Min Jour–Aug. 1. 1000 w.

*7446. A Victorian Mount Morgan (Account of a very rich field recently found in Australia). Min Jour–July 25. 1800 w.

*7447. The "Wild West Coast" of Tasmania. F. E. Harris (The first part is largely descriptive of this country of vast mineral wealth). Min Jour–July 25. Serial. 1st part. 3200 w.

*7448. Gold Mining in Colorado as an Investment. Thomas Tonge (Favorable account and claiming there is no better opening for the judicious investment of capital). Min Jour–July 25. 1800 w.

*7455. The Mining Boom in Tasmania (Report by Mr. Montgomery on mines that have been worked for some time). Aust Min Stand–June 18. Serial. 1st part. 6300 w.

7504. Elkhorn Mountain and Rock Creek District of the Blue Mountains, Oregon. Robert W. Barrell (Description of this district, which the writer considers a very favorable field for capital to invest in mining). Eng & Min Jour–Aug. 8. 1500 w.

*7540. The Mining in and Around Herberton, North Queensland. John Munday (Paper contributed to the Aust. Assn. for the Advancement of Science. Describes lode mining and alluvial mining in this locality, and machinery used). Min Jour–Aug. 1. 2800 w.

*7541. Notes on the Explosion of Coal Dust. W. J. Orsman (From a paper recently read before the Federated Inst. of Min. Engs. A review of demonstrated facts with other information). Min Jour–Aug. 1. 1500 w.

Miscellany.

*7039. The Carriage of Coal on Railways and Canals (The essential statutory provisions on the question in England, including a brief account of the special tribunals which have been established to determine disputes respecting the carriage of coal on railways and canals, followed by the leading points of cases which have been adjudicated by the Supreme and Appeal Courts, and the Railway and Canal Commissioners). Col Guard–July 3. Serial. 1st part. 3200 w.

*7040. Railway Companies and the Carriage of Coal (A copy of the circular issued by the Midland, Great Northern and London and North-Western railway companies on the subject of charges for the conveyance of coal, with action taken by the Coalowners' Assn). Col Guard–July 3. 600 w.

*7041. The Hungarian National Exhibition (A description of the interesting mining exhibit). Col Guard–July 3. 2500 w.

*7042. Precautions Necessary in the Use of Electricity in Coal Mines. H. W. Ravenshaw (Read before the Federated Inst. of Min. Engs. A few suggestions the carrying out of which may serve to minimize the risk both from shock and fire). Col Guard–July 3. 3000 w.

7091. Uniform Methods of Testing Iron and Steel (Summary prepared by Henry B. Sea-man, of the recommendations of the committee of Am. Soc. of Civ. Engs. as given in their general report). Eng News-July 16. 1800 w.

*7124. Baku and Its Oil Industry. W. F. Hume (Interesting account of the rapid growth of the town due to its excellent harbor and the oil supply. Historical account of the growth of the naphtha industry, description of the wells and method of working, with other interesting information). Nature-July 9. 2400 w.

7127. The Geological Age of Gold, Dan De Quille (Concludes that gold bearing veins have been formed in all ages, but locally at different times). Eng & Min Jour-July 18. 1600 w.

7142. A Special Hydraulic Coal Tipper at Ruhroit (Illustrated description. The excess of power furnished at the time of filling is utilized to raise the empty truck). Am Mfr & Ir Wld-July 17. 300 w.

7143. Nitrogen in Coal. William Foulis (Abstract of address before the Incorporated Institution of Gas Engineers. Suggestions pointing out the direction in which further investigations may be made to recover the greater portion of the nitrogen now lost in the coke). Am Mfr & Ir Wld-July 17. 1400 w.

7144. Coke Production in 1895. Jos. D. Weeks (Extract from report made to the United States Geological Survey. Shows the production outside of the Appalachian region is a growing one). Am Mfr & Ir Wld-July 17. 1500 w.

†7153. The Petroleum Industry in Japan (Editorial on the value of the oil industry in Japan and the effects on the markets of China and India). Ind Engng-June 13. 600 w.

*7163. Coaldust and Explosives. H. Richardson Hewitt (Abstract of a lecture before a meeting of undermanagers and deputies of the Gresley and Coalville districts. History of the subject, with opinions of the writer). Col Guard-July 10. 2800 w.

†7166. Report on Indian Coals (Letter to the editor quoting from report by Sir Frederick Abel). Ind Engng-June 20. 350 w.

7255. Sepiolite. R. Helmhacker (Description of formation, locating deposits, and qualities of this mineral). Eng & Min Jour-July 25. 2000 w.

*7257. The Coal Owners and the Wages Question (Statement of Thomas Ratcliffe Ellis, secretary to the Federated Coal Owners, with regard to the present position of the wages question in the coal trade). Col Guard-July 17. 2800 w.

*7258. Electrical Haulage at a German Colliery. Herr Koepe, *Zeitschrift des Vereins deutscher Ingenieure* (Description of the installation at the Ewald pit, near Herten). Col Guard-July 17. 1200 w.

*7259. Afterdamp. T. Getrych Davies (Read before the So. Wales Inst. of Engs. The writer's experience in dealing with the gases met with after colliery explosions). Col Guard-July 17. 2000 w.

†7263. Brazil: Minerals, Mining, etc., of the State of Bahia (Report of consul on the minerals and metals of this region). Cons Repts-July. 1600 w.

*7287. Dr. Haldane on Carbon Monoxide Poisoning (Reference made by Frank Clowes to the work of Dr. John Haldane, with extracts from his report on "The Causes of Death in Colliery Explosions, etc"). Jour of Gas Lgt-July 14. 2200 w.

*7291. Petroleum (Where found, how obtained, and the manner of using it, with illustrations). Mach, Lond-July 15. 1800 w.

†7323. Faulting and Accompanying Features Observed in Glacial Gravel and Sand in Southern Michigan. Carl Henrich (Interesting geological features, with a possible explanation of the cause). Trans Am Inst of Min Engs-July. 1300 w.

†7324. Vein-Walls. T. A. Rickard (Interesting study of the subject with many illustrations). Trans Am Inst of Min Engs-July. 12000 w.

†7330. Rapid Section Work in Horizontal Rocks. Marius R. Campbell (A new system introduced by the writer which has met with general approval). Trans Am Inst of Min Engs-July. 5400 w.

†7331. Gold in Granite and Plutonic Rocks. William P. Blake (Examples showing that we must recognize such rocks as truly gold bearing). Trans Am Inst of Min Engs-July. 2800 w.

*7434. Explosive Mixtures of Combustible Gases with Air. Frank Clowes (Summary of a lecture delivered at the Gas Inst. Deals with the explosion of combustible gases and the limits; poisonous constituent in coal gas, gaseous fuel, and in the products of their incomplete conbustion; detection and measurement of carbonic oxide, etc). Col Guard-July 24. 2800 w.

*7494. The New South Wales Coast. Joseph E. Carne (Its geology and mineral resources). Aust Min Stand-July 9. 2000 w.

7502. The Occurrence of Platinum in New South Wales. J. B. Jaquet (Abstract of reports. Account of discovery and work). Eng & Min Jour-Aug. 8. 900 w.

7503. The Mineral Fuels of Manitoba and the North West Territories. William Pearce (A subject of interest to settlers as a portion of the country is to a large extent a treeless plain. Coal, natural gas and petroleum have been found). Eng & Min Jour-Aug. 8. 2200 w.

7505. Some Minerals Found in the Republic of Guatemala. John Rice Chandler (List of minerals with location and brief description). Eng & Min Jour-Aug. 8. 1000 w.

*7512. The Rate of Increase of Temperature with the Depth of Subterranean Operations (Notes of investigations and experiments on the subject). Col Guard-July 31. Serial. 1st part. 1400 w.

7533. Brookwood Coal Washer. F. M. Jackson (Read before the annual meeting of the Alabama Industrial and Scientific Society. Describes and illustrates the washer in successful operation by the Standard Coal Co., of Brookwood, Ala). Am Mfr & Ir Wld-Aug. 7. 1200 w.

Effects of Steam Road-Rolling on Gas and Water Mains.

IN this department of our May number a paper upon the effects of steam road-rolling read by Mr. H. Humphreys before the Institute of Civil Engineers was reviewed. The subject was again taken up for discussion before the Association of Municipal and County Engineers at Brighton, England. The injury resulting to drains and pipes was admitted, and the following rules for putting down drains and mains, adopted in Nottinghamshire, were read by one of the members:

"When road material or foundation is taken out, it shall be properly sorted, and any portion that may be soft or wet shall be entirely removed from the roads. The trench shall be re-filled with as much of the dry material as the county surveyor shall consider fit for the purpose: provided always that the foundation of the road shall be made up with four inches of hard dry core, cinders, or rammel, with a final coat, four inches thick, of new, good, sound metalling, similar in character to that of the existing road. As each layer of the new filling-in and road surface is made, it shall be thoroughly well rammed. Should any unevenness afterwards occur, the road surface shall be made good with approved sound road material. Pipes and drains laid beneath any road under the jurisdiction of the county council shall, if within three feet of the surface of the road, be covered with at least six inches of concrete surrounding the pipes or drains, or the pipes or drains shall be constructed of iron. It must be clearly understood that all pipes and drains shall be laid so as to permit a steam-roller to be used at any time over the same; and the council shall be held free, in case of any accident happening to the pipes or drains—the cost of re-instating any pipe or drain that may be broken or damaged being borne by the authority, company, or persons laying or owning the pipes or drains."

The gentleman who brought these rules to the notice of the meeting said that such pipes and mains as had been injured in Nottinghamshire have usually been those that required abolishing by reason of their bad condition.

Another member complained of the difficult position in which engineers were placed with reference to damages. Anyone using a steam-roller was liable for the damage done by that roller to gas or water mains, unless he could prove that the pipe damaged had been improperly laid. This was a very difficult thing to do. If the company gave evidence to the effect that the pipe was properly laid, it was a very hard matter for the local authority to prove it was otherwise. What he apprehended was that some day or other there would be a serious catastrophe. There would be a leakage of gas, resulting from a fracture of the mains, which would blow up two or three houses, and cause several deaths; and there would be a big bill to pay. Then this question of liability would be brought before them in a very unpleasant way.

Another member, who had been compelled to quit using a fifteen-ton roller and substitute for it a ten-ton roller by the action of a gas company which feared injury to its mains, said he had obtained nearly or quite as good results by the use of the ten-ton roller, leaving it to be inferred that the use of heavier rollers was not necessary. He also asserted that the ten-ton roller did just as much work as the fifteen-ton roller. Another member fully agreed with this statement, as the result of his experience. It appears from this discussion that the use of the fifteen-ton rollers is being discontinued by some engineers, except in making roads under which there are no pipes. One member recounted his experience with the heavy roller, from the use of which an explosion of gas resulted, and said that since that time the use of a roller weighing more than ten tons has been prohibited in Brighton, except in suburbs where there are no underground pipes to be injured.

A New Setting for Gas Retorts.

THIS new system of setting retorts has been discussed in various journals devoted to the gas industry, and all seem to concede that it is another stride in the progress of the art. *The Engineer* (June 5) has published an illustrated description, which we draw upon for this review.

The new setting obviates any interruption of fires or accidents to firemen that may occur in drawing the red hot coke from the retorts into the coke-hole, and effects a considerable saving in labor and in space now required for shovelling back the quenched coke towards the walls of the house. This handling of the coal breaks it up more or less into breeze; hence more of the coke is retained in good condition by the avoidance of the shovelling alluded to.

The first setting of this sort was built at the East Greenwich works of the South Metropolitan Company, England, at which works the method has had a trial during the past winter and present summer, and, it is said, has achieved unqualified success.

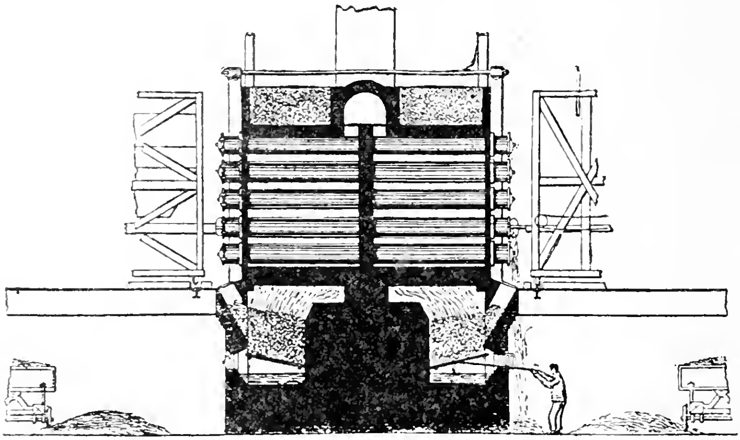
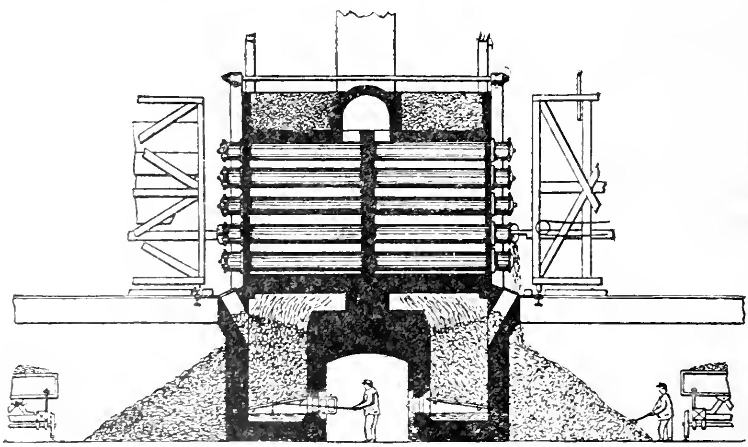


Fig 1.



JOYCE'S GAS RETORT SETTING

The accompanying engravings illustrate the description.

Instead of making the bench solid, as shown in Fig. 1,—the old way,—"The system consists, as shown in Fig. 2, in forming a tunnel in the middle of the retort bench, extending throughout its length, and on a level with the floor of the ovens. The doors of the furnaces on both sides of the bench open on to this tunnel, and the clinkering and raking of the fires are done from it. The fuel is fed into the generator at a mouthpiece on the stage-level, but in all other respects the furnaces are in effect reversed, and the faces of the stack below the stage are unbroken by doors or dampers. The firemen do not enter the coke-hole, and its capacity for coke storage is much increased. The coke is quenched and loaded direct into the wagons without previous handling. The firemen working in the tunnel are not interrupted by the drawing of the retorts, and thus a saving of labor is effected, while the furnaces are accessible for inspection at all times. In constructing a bed on the tunnel system there is a saving of bricks, as the solid mass of brickwork in the middle of the bench is considerably diminished. It is claimed for the system that in one year it effects a saving more than sufficient to compensate for the outlay of converting existing benches to it. The South Metropolitan Gas Company have been so well pleased with the working of the experimental bed that they have now nearly completed the work of converting the beds in all their retort houses at East Greenwich to the new system. The benches and system of firing at that works were very favorable to the conversion, and undoubtedly a great economy has been effected.

"In other cases, as when a flue runs the length of a stack in the position required by the tunnel, greater but not insuperable difficulties would be offered to the work of conversion. The coke-hole space at East Greenwich is very cramped, and no doubt the make of breeze under the old system of working was greater there than it is at many works, and for the same reason fatal accidents to firemen appear to have been of more than common frequency there. But in houses where the coke-hole is of ample width we have witnessed bad accidents to firemen from the falling coke and tar, and, as a preventive of these, Joyce's tunnelled beds are to be commended. In these same wide retort-houses, too, the labor expended in shovelling back the coke from the face of the stack towards the wagons is immense, and therefore the dictates of economy would favor the adoption of the tunnelled retort beds. When the system is being introduced in a new setting, several minor improvements may be made, such as shoots from the top of the stack into the tunnel, which save much labor with the wheelbarrow. Some settings now in course of construction at the East Greenwich works will have this useful addition to the tunnelled retort beds."

In conclusion, *The Engineer* expresses the belief that this is one of the most valuable improvements in retort houses which has been produced in recent years.

How Water Meters Should Be Set.

FROM a report of a committee of the American Water Works Association rendered at the recent Indianapolis meeting of that body, the following summary of the principal essentials is prepared.

The plan of placing meters in cellars, while presenting the advantage of protecting them from frost, is objectionable on account of inaccessibility when tenants are absent, the danger to inspectors of the attacks of vicious dogs, etc. Setting meters in pits in side-walks or yards in cold climates is also objectionable, though in warm climates it is not so, the inconvenience of uncovering the pits from snow and ice being the principal objection to this position. From careful consideration of the facts the committee arrived at the conclusion that no position that will be generally applicable can be fixed upon. The recommendation is made, however, that all meters be set either by the water departments or under their immediate supervision. Each water department should endeavor to have all its meters set in a uniform manner. This will be found to aid greatly in removing, repairing, and reading. The inlet and outlet of meters should be plugged up before being shipped, to prevent foreign matter from accumulating in them. They should be thoroughly blown out and subjected to a bench-test under varying deliveries before being set. They should in all cases be set level, when possible, and should also have strainers attached to the pipe connection. The size and kind of meter for each service should always be specified by the water departments. Meters supplying steam boilers should have a check-valve placed between the meter and the boiler, provided, however, the boiler is equipped with a safety valve. If this precaution is not taken, serious consequences are likely to ensue. In all cases a stop and waste-cock should be placed between the meter and street main; also a stop-cock between the meter and riser, cr services. This wiil be found a great advantage in removing and testing meters, and will more than repay the additional outlay. No lead of any kind should be used in making joints.

When meters are set in cellars, they should be placed as near the wall as possible, and they should also be accessible for light repairing, removal, and inspection. When there is danger from frost, the meter should be encased in a wooden box of suitable size, with a hinged cover, and packed around with sawdust, mineral wool, or other non-conducting material. When meters are placed in sidewalks or yards, they should be set in either a brick pit or an iron or wooden box, which should be of such size as to allow of its removal without disturbing the box. The pit or box should have an iron cover (preferably hinged) with some locking device, to prevent tampering and depredations. The meter should be set at such a depth as to prevent freezing, and, if necessary, packed around with sawdust or other suitable material. In extreme cases it would be advisable to construct the pit with a false bottom and fill above this with sawdust. The question of material for the box or pits is one to be decided according to circumstances, remembering, however, that brick and iron ones are more economical in the long run. In setting meters in the sidewalk, the meter should be placed about eighteen inches inside of the curb, and under no circumstances be nearer the wall of building than two feet. In setting in any of these positions described, the meter should always be equipped with the cocks, etc., above named.

An Illustration of the Utility of Water Meters.

EDITORIALLY *The Engineering Record* calls attention to the experience of the municipal government of Richmond, Va., in an abstract of a report for 1895, of Mr. Charles Bolling, superintendent of the water-works of that city, and cites this experience as an illustration of the economy which results from the employment of water-meters. One of the incidents connected with the use of meters is as follows:

"The Chesapeake & Ohio Railway has a tank supplied from the city mains. In July last 2,428,900 gallons passed through the meter, making the bill for the month $170.02. The company promptly objected to the amount of the bill. Upon examination, a large hole was discovered in the pipe leading from the tank, and through this water was flowing to an underground drain. This was repaired, and the bill for August was $34.30. Had there been no meter there, the leak would not have been discovered, and the city would have lost $1,508 worth of water in one year.

"In 1894 651 meters were set, and the pumpage for that year was 1,000,000 gallons per day less than in 1893. In 1895 282 meters were added, and the pumpage was 500,000 gallons per day less than in 1894. That is, although 875 taps had been added in these two years, the quantity of water pumped was reduced 1,500,000 gallons per day. Nearly all these meters have been set in the higher portion of the city. Had they been set in the lower portion of the city, where the pressure is greatest, the saving would probably have been greater. As it is, an improvement in the pressure at several of the high points is already noticeable."

The editorial reviewed makes a point not noticed in Mr. Bolling's report,—to wit, that "such leaks as he describes not only cost the city for the water lost, but lead to a demand for expensive additions to water-works before they are actually needed or can be afforded."

A committee of investigation, to consider and report upon the average consumption *per capita* in Richmond, reported that the consumption averaged 126 gallons per head, of which only five per cent. is metered. "The committee estimated that 60 gallons daily would be a proper *per capita* allowance for a city as far south as Richmond, and recommended that meters be introduced to reduce the consumption to this figure, in preference to increasing the capacity of the works. As the present capacity of the works is 12,000,000 gallons daily and the population 95,000, it will be seen that the population of Richmond could be doubled before an enlargement of the works would be needed, if the waste of water was checked as recommended, and that there would seem to be no need of burdening the citizens of Richmond with the expense of enlarged works that more properly should be borne by the next generation." Perhaps no better example of the salutary effect of meters in preventing careless and wanton waste of water could have been selected, than this.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Municipal Engineering in the American, English, and British Colonial Engineering and Municipal Journals—See Introductory.

Gas Supply

*6985. The Important Future of Producer-Gas. Ill. A. Humboldt Sexton (Showing the advantages of gaseous fuel and the various methods of producing it). Eng Mag-Aug. 4200 w.

7032. Acelytene Gas. George Black (A general essay, historical and descriptive). Can Elec News-July. 3800 w.

7115. Prepayment Meters. M. Van der Horst (Three months' experience with these meters in Utrecht, Holland). Pro Age-July 15. 1800 w.

7423. The Wrecking of Holder No. 1, Station C, of the Laclede Gas Company During the Recent Cyclone at St. Louis, Mo. D. L. Hough (Profusely illustrated description). Pro Age-Aug. 1. 800 w.

*7424. Some Labor-Saving Methods in Photometrical Testing. Henry O'Connor (Read at the annual meeting of the North British Assn. of Gas Managers. The use of the graphic method in photometrical work, and the substitution of mechanical means for this method. Also discussion). Gas Wld-July 25. 3000 w.

*7425. The Permanency of Illuminating Gas. William Young (Read before the N. Brit. Assn. of Gas Managers. The effect of vapor tension and absorption of illuminating constituents by oil, modifications of permanency, etc). Gas Wld-July 25. 6800 w.

†7457. The Welsbach and Other Incandescent Gas Lights. George S. Barrows (Descriptions of fair examples of this large family of gas-lights, and a description of the process of manufacture of the Welsbach light at Gloucester. Discussion). Pro Eng's Club of Phila-July. 3000 w.

Sewerage.

†7061. Which Should Have the Steeper Grade, Main Drain or Laterals? (A general discussion). Ill Soc of Engs & Surv-11 An Rept. 1800 w.

7107. Surface Drainage of Suburbs (Abstract of a report (1895) by Bertrand T. Wheeler, Supt. of Streets, Boston, Mass.). Eng Rec-July 18. 1200 w.

7284. The Providence Sewer Tunnel (Illustrated description). Eng Rec-July 25. 600 w.

*7408. Intercepting and Relief Sewers. Charles Carroll Brown (The object of the writer is to show that the principles of intercepting and relief sewers can often be applied with advantage to the sewer system of small cities). Munic Engng-Aug 1500 w.

Streets and Pavements.

*7176. How to Lay "Cement" Street Paving (Plain practical directions for paving, with illustrations of kinds of work, description and cuts of tools). Ill Car & Build-July 10. 1700 w.

Water Supply.

7020. The Cold Spring, N. Y., Concrete Dam (An illustrated description of some interesting features of a system of water-works just being completed at place named). Eng Rec-July 11. 1300 w.

†7055. A Novel Test of the Flow of an Artesian Well. W. D. Pence (Water bearing stratum reached at 700 feet below surface. Tests were made for determining head as well as flow). Ill Soc of Engs & Surv-11th An Rept. 2200 w.

7088. A Small Asphalt Lined Reservoir at Indio, Cal. J. B. Lippincott (Description. Composition of the asphalt concrete. Experience and general remarks). Eng News-July 16. 600 w.

7105. The Galveston Water-Works (Illustrated description. Part first contains history of development and investigation, map and profile, proposed and adopted location of wells, designed and constructed standpipe, suction well, determination of size of conduit and analysis of engine requirements). Eng Rec-July 18. Serial. 1st part. 2500 w.

7129. Laying Water Mains. J. H. Decker (Common sense remarks and suggestions). Fire & Water-July 18. 1800 w.

7282. Some of the Factors Which Determine the Efficiency of Filters for Water Purification. James H. Fuertes (Description of European methods of solving the problem of efficiency. Theoretical considerations affecting the question systematically presented, in connection with actual mechanisms employed). Eng Rec-July 25. Serial. 1st part. 2800 w.

7283. The Fort Field Reservoir, Yonkers, N. Y. (Illustrated description). Eng Rec-July 25. 800 w.

7288. Report of Committee on Best Methods of Setting Meters (Presented to the convention of the American Water Works Assn. at Indianapolis. Deals with the practical details of position, size, etc., of water meters for different services). Fire & Water-July 25. 900 w.

†7310. The Purification of Public Water Supplies. George H. Rohe (Address delivered at the meeting of the American Medical Assn. at Atlanta, Ga. A general review of the subject in its relation to public sanitation, and the prevention of epidemic diseases). San-July. 3000 w.

7365. Some Facts about Slow Sand Filtration of Water. Mrs. Percy Frankland (The fluctuations in the quality of filtered water as indicated by systematic bacterial examinations are noted, with conspicuous examples ; and while efficient filtration is of the highest sanitary importance, it is shown that this does not render us independent of the nature of a water supply). Eng News-July 30. 1300 w.

7370. Flowage Test of a 14-in. Riveted Steel Main at New Westminster, B. C. A. McL. Hawks (Description of pipe and of tests). Eng News-July 30. 2000 w.

†7388. Schönheyder's Positive Water-Meter (Illustrated description of a new form of this meter brought out in 1895). Ind & East Eng-July 4. 1400 w.

*7413. Water Supply (Editorial. General considerations relating to features of municipal engineering practice and apportionment of water rates). Engng-July 24. 1400 w.

7415. Evolutions of Water Supplies. J. T. Fanning (Abstract of a paper delivered before the Indianapolis convention of the Am. Water Works Assn. Some interesting facts). Eng Rec-Aug. 1. 1200 w.

†7458. The Water Supply of Rome. Henry Leffmann (Description of ancient water works of Rome, compiled from a variety of sources which the author names, and which form a sort of bibliography of the subject). Pro Eng's Club of Phila-July. 3500 w.

7482. The Water Supply for San Diego, Cal. (The steps taken toward municipal ownership of the water-works. The developing the supply includes a rock fill dam with an asphalt face 3100 ft. above the sea, and some 50 miles of conduit). Eng News-Aug. 6. 700 w.

7508. The New Arched Dam at Nashua, N. H. (Illustrated description of the new dam of the Pennichuck Water-Works Co , of Nashua, N. H). Eng Rec-Aug. 8. 1100 w.

*7555. Masonry Dams, Remscheid and Chemnitz Water Works (Illustrated description). Eng, Lond-July 31. 900 w.

*7557. Discharge Tunnels from Reservoirs. James A. Paskin (Points in construction that demand special attention under special conditions). Eng, Lond-July 31. 2200 w.

Miscellany.

7018. Garbage Cremation in Europe. James H. Fuertes (Describes cremation as the author personally saw it carried out in the city of Hamburg, and also in Leeds, Eng., with some experimental data). Eng Rec-July 11. 2300 w.

†7052. The Disposal of Garbage. Charles S. Hill (Considers this a new and important field for engineering effort, and discusses its general features). Ill Soc of Engrs & Surv-11 An Rept. 3500 w.

†7056. Tests of a Vitrified Earthenware Water Conduit. Dabner H. Maury, Jr. (The pipes were 24″ diameter. The construction of the conduit is described, the nature of the tests explained, and extensive table of data is presented, with discussion). Ill Soc of Engs & Surv-11 An Rept. 4500 w.

†7057. Sanitary Engineering and State Boards of Health. Jacob A. Harman (Review of work done by State boards of health, with discussion). Ill Soc of Engs & Surv-11 An Rept. 6500 w.

7106. Final Disposition of the Wastes of New York City (Extended abstract of a report by George E. Waring, Jr., Commissioner of Street Cleaning of New York). Eng Rec-July 18. 2000 w.

7111. A Fabric of Misstatements (Editorial criticism of the paper entitled "The Municipal Ownership of Gas Plants" read before the recent New Haven street-lighting convention). Pro Age-July 15. 3000 w.

7112. The Reply of Houston, Kennelly and Kinnicutt, to Criticisms on the Progressive Age Report, Concerning the Cost of the Carbide of Calcium (Editorial comment). Pro Age-July 15. 700 w.

7113. Reply of Progressive Age Commissioners to Criticisms on the Cost of the Carbide of Calcium (In this reply the various criticisms and allegations which have appeared in different papers and which tend to throw doubt upon the validity of the conclusions arrived at by the commissioners, are met seriatim, and supplemented by press comments upon the work of the commissioners). Pro Age-July 15. 3000 w.

7114. Standards of Light. Edward L. Nichols, Clayton H. Sharpe. and Charles P. Matthews (Preliminary report of the sub-committee of the Am Inst. of Elec. Engs., presented at the general meeting, New York, May 20, 1896). Pro Age-July 15. 4500 w.

†7309. More About the Public Rain Baths. Moreau Morris (Read at the Conference of Charities, New York. Historical sketch of the attempts that have been made to establish free public baths in New York city, of which the public rain baths are the latest phase). San-July. 5600 w.

RAILROADING

Articles of interest to railroad men will also be found in the departments of Civil Engineering, Electricity, and Mechanical Engineering.

The Prolonged Era of Economy.

THE extent to which rigid retrenchment and reduction of expense still prevail in the administration of railroad affairs generally throughout the country is well illustrated in the statistics just published by the interstate commerce commission, abstracted from the eighth statistical report of that body. True, there are signs here and there of a feeling of greater financial freedom, but these are not numerous or important enough to affect much the general impression.

The year's increase of mileage was lower than ever before, even in 1894, being but 1,948.92 miles, or 1.09 per cent. Fourteen roads were abandoned, 9 merged, 32 reorganized, and 28 consolidated, none of which processes suggest financial expansion.

The increase in number of locomotives in service was but 207,—not an adequate proportion even to the small increase in mileage; the cars of all classes in service actually decreased 7,517, and in freight-cars alone the decrease was 9,050, though this is partially due to the increase of non-reporting private line equipment.

The total number of employees was slightly increased, being 785,034 on June 30, 1895, or 5,426 more than at the corresponding date last year; but the increase appears to have been in maintenance of way and maintenance of equipment, and some other departments where economy has over-reached its limit; in five groups of employees there was a decrease.

It is not surprising to find that the same reluctance to incur any expense appears again with marked effect in the figures of train-brake and automatic-coupler equipment. Out of a total of 1,306,260 locomotives and cars, only 362,498 were fitted with train-brakes, and 408,856 with automatic couplers, on June 30, 1895, the additions for twelve months being but 31,506 as to train-brakes and 51,235 as to couplers, the deficiency being especially noticeable in the locomotives in freight service.

When the statistics of operation and of finance are examined, the reasons for the minimizing of expenditure are readily apparent. Freight-tonnage, indeed, increased about 8 per cent., the total number of tons carried being 696,761,171; but the haul was, in the average, shorter, and the number of tons carried one mile (85,227,515,891) was but 5.74 per cent. greater than in 1894. Passenger business, on the other hand, showed a marked decline, 507,421,362 passengers being carried altogether,—33,266,837, or about 6.5 per cent., less than in 1894; but the passengers carried one mile were about 16 per cent. less than in the preceding year. As a net result, passenger revenue decreased 11.6 per cent., and freight receipts increased only 4.36 per cent.

The ratio of operating expenses to operating income, which in 1894 was 65.80 per cent., in 1895 was 67.48 per cent. The total income from operation was somewhat greater than in 1894, but the increase was more than wiped out by the decrease in income from investments and other sources, and the railways of the United States closed the year with a deficit from the year's operations of "$29,845,241, which was met by a decrease in accumulated surplus, or by the creation of current liabilities."

Stock to the amount of "$3,475,640,203, or 70.05 per cent. of the total outstanding, paid no dividend, and $904,436,200, or 16.90 per cent. of funded debt, exclusive of equipment trust obligations, paid no interest during the year covered by the report." And, "of the stock paying dividends, 6.89 per cent. of the total stock outstanding paid from 4 to 5 per cent.; 5.39 per cent. of this stock paid from 5 to 6 per cent.; 4.41 per cent. paid from 6 to 7 per cent.; and 3.99 per cent. paid from 7 to 8 per cent. The average rate on all the dividend-paying stocks was but 5.74 per cent.; the average return on the entire railway stock capitalization of the country was about 1.74 per cent."

And now come the framers of the Chicago platform with a demand "for the enlargement of the powers of the interstate commerce commission, and such restrictions and guarantees in the control of railroads as will protect the people from robbery and oppression." From the report of the commission itself, it appears that robbery is a most unprofitable occupation, and the oppressor barely escapes from starving on his spoils.

American and British Permanent Way.

OUR highly esteemed contemporary, *The Engineer*, seems to be having a terrible time over the question of permanent way. Some of its unfeeling correspondents persist in urging "that American track is so much better" "that no time should be lost in discarding the English cross-sleeper and chain for the flanged rail and tie," and, as *The Engineer* holds "that the normal English road, with a 90-pound or, better still, a 100-pound rail, makes the best track in the world," this is very painful to its feelings, and necessitates repeated self-administration of editorial argument to neutralize the apparently highly disturbing effects of these suggestions.

However, having again attained a comfortable composure, which "will not concede for a moment" that English roads "have anything to learn from American practice," the present attack seems to be over, and the American roads at least have lost nothing thereby.

The curious thing is that, so far as can be discovered by a thorough examination of the exchanges, *The Engineer* is doing this furious battle solely against shadowy figures of the mist,—ghostly shapes of correspondents whose exasperating effect can hardly be explained, unless, indeed, like specters in the hands of the dramatist, they are the counterpart of certain uneasy operations of the mind, and merely embody with hideous concreteness vague suspicions which *The Engineer* would rather bury from its own sight in its own soil.

Imagine the *Railroad Gazette* coming out in every other issue with an elaborate argumentative defence of "American track;" and yet, as *The Engineer* remarks, "nothing like finality has been arrived at" on this side as to many details. But this evidences only the flexibility of the type,—a merit, not a defect or limitation.

As *The Engineer* has been allowed to have the discussion so completely to itself, it may interest some of those who do not see it to know how defective our product appears to an unsympathetic observer. The italics are ours. "When yellow pine or softer woods are used (for ties), it has been found *necessary* to interpose between the rail and the wood a large piece of boiler-plate."

Even with eighteen ties to the rail, "the roads are far from perfect; *very great difficulty* is experienced with the joints;" "one of the most serious objections to the flanged rail is that it is *next to impossible* to fish it satisfactorily."

It is "a road very difficult to repair, because the removal of a rail in practice means the destruction of the sleepers"; "the sleeper is virtually ruined by the extraction of the spikes, and we believe it is the practice on most, if not all, first-rate roads to put down new ties whenever rails are renewed." *The Engineer* is entirely misinformed. It is not the practice to do anything of the kind.

These renewals seem very alarming things: it might almost be inferred that the chief occupation along a railway line was taking up rails and relaying them. "A gang of plate-layers," we are told, "could replace a couple of lengths of rail before an American gang would get the spikes out." It would be interesting to see the test; but, after all, the more important consideration is to keep a good smooth track *down*.

Lastly, *The Engineer* finds a "mystery" in the reported failure of an experimental section of "normal" English track under American rolling-stock on the Pennsylvania railway.

"The speeds on the Pennsylvania Railway are not greater than those used on the London and North Western, Midland, and other first-class lines here. The loads carried per wheel are almost the same; rather heavier, we think, in this country than in the United States." * * * "And now we are told by one eminently qualified to make the statement that a first-class English road will not bear American rolling-stock." Some one should tell our doubting friends that American rolling-stock is very much heavier than English. The load of 18 tons per axle, which it cites as having been attained in English practice, is evidently in locomotive building; an equal weight per axle is not at all unusual in American engines.

Our heavier sleeping-cars are nearly or quite as heavy as a locomotive; and in total weight of trains, or in weight imposed per rail, there is no comparison.

The record-breaking train on the Lake Shore, by which (to quote *The Engineer's* still suspicious language) such "enormous speeds are said to have been attained," weighed about 225 tons,—just about the weight of an average English express train; but it was a very light train of three cars only. It is not at all unusual for through trains on our trunk lines to be made up of ten cars or more, six or seven of them being sleepers of the heaviest type, making a load of 500 tons behind the tender.

The English roads have not yet offered anything nearly approximating such weights as this; but the amusing surprise and satisfaction with which the "corridor-cars" on the east and west coast lines have been received may grow into a demand from the British travelling public for greater comfort, and inaugurate a revolution in favor of a nearer approach to American standards of car-building.

If this should practically transfer American rolling-stock to British roads, there is little doubt that the result of the Pennsylvania experiment will be repeated in England.

But *The Engineer* certainly is in a position exciting sympathy. It is very annoying to find facts obstinately antagonizing an *a priori* conclusion. The most comforting course is to discredit the facts, but such comfort is unfortunately transitory.

The Railway as an Exponent of Civilization.

THERE is something taking about this title; it has not, so far as we know, been seized upon by any railroad essayist, but it would furnish a fine text for a writer gifted with a broad and intimate knowledge of his subject and fired by a fine enthusiasm for its importance.

The railroad is classed, by many careful thinkers, as beyond all question the most powerful influence upon modern life in its broadest significance. For, beyond its potent effects on commerce, industry, and finance is the more important, if somewhat less tangible, force it has exerted on thought, education, social customs, and political conceptions. It has endowed the national body not only with more powerful and fully-developed muscles, but, far more than this, with a new and most highly developed nervous system, bringing every remote member into intimate connection with the great centers, and binding all together in a community of feeling and an interdependence of existence never before dreamed of. It overleaps geographical and political boundaries, tying nations together with bonds that can hardly be broken; for one word written on strategic lines of railway in war, there might be ten thousand for its continuous and well-nigh unbounded influence for peace.

As a southerner remarked to the writer some months since, standing on one of the crumbling earthworks near Nashville, from which rifle bullets and fragments of shell can yet be gathered after every rain: "If the railroads of 1860 had been like the railroads of 1896, these little difficulties could never have taken place."

The first effective taming of the wilderness comes just in the wake of the track-laying gangs; the notes of progress are sounded on the locomotive whistle, and the index of the industrial, the social, almost of the moral status of a country is to be found in its railway systems.

But just how this exponent is to be

written is harder to define, and the general equation which shall determine it for any given case apparently can not be determined, even from the elements given in the mileage statistics adapted by *The Railway Gazette* from the *Archiv für Eisenbahnwesen*. Taking the totals alone, as thus summarized:

North America	202,983	miles
Europe	152,417	"
Asia	26,078	"
South America	23,799	"
Australia	13,795	"
Africa	8,143	"

there is at once manifest a certain general relation which is in accordance with expectations, and, when we find that the United States alone has 179,297 miles of the total on the continent, it is very gratifying to our conviction that ours is the greatest and most enlightened country on the earth. But, when we compare relations of mileage to area, we fall suddenly and far from our proud position; we have but 6 miles of railroad to every 100 square miles of territory, while Belgium heads the list with 30.3, and Great Britain and Ireland comes second with 17.2, followed by Holland with 14, Switzerland with 13.7, Prussia with 12.4, France with 12.1, Denmark with 9.3, Italy with 8.2, and Austro-Hungary with 7.1. On this basis we have to be content with tenth place. It is some consolation to find that the other European States pull the general average down to 4 miles per 100 square miles, so that, compared with the continent as a whole, we still retain our supremacy.

If we take population as a basis, we are in much better case, for we have 26.2 miles for every 10,000 inhabitants, while Europe as a whole has but 4.1. True, Australia leads us with 32.4 miles, British North America and Newfoundland with 31.9, and the Orange Free State with 29.8. Even Argentina and Uruguay, with 19.1 and 14.9 respectively, are closer than we would have been willing to admit; but Great Britain with but 5.3, Belgium with 5.5, and France with 6.4 are hopelessly out of the race. Austro-Hungary (4.2) barely exceeds the average of all Europe, and even Sweden, with its leading figure of 11.8, is not within hearing of the eagle's scream.

The rear is brought up by Dutch India, with but .4 mile to 10,000 inhabitants, although close contestants for the "booby prize" are English India and Japan, with but .6 mile each.

A significant feature is the wide range of countries and districts brought into the circle of railroad influence, many of them most incongruously to our sense of association. Probably, before long, the man who goes down from Jerusalem to Jericho will go by rail, and, if report of Turkish roads be correct, will share the experience of the "certain man" who was in so sore need of the attentions of the Good Samaritan.

An Indian road, recently opened, expects to derive its revenue from pilgrim devotees to the shrine of Jaggernath. The Jungfrau is to be robbed of her coyness and inaccessibility.

The time is almost in sight when the pigmies of Africa, instead of hiding in impenetrable bush and greeting a Stanley with poisoned arrows, will lounge about the station platforms, spitting tobacco juice at the "schedule of commutation rates" of the Central African Trunk Line, and pestering the agent to know when the second section of No. 94 is coming along.

A Precaution as Bad as the Disaster.

A MOST deplorable instance of reckless daring, of misconceived execution of duty, and of a method of "testing" which provokes the disaster a proper means should avert, is furnished in the following paragraph from *The Railway Age*.

"A sad example of devotion to duty at the cost of life occurred on the Vandalia line near Crawfordsville, Ind., on the night of July 28. Roadmaster Brothers, fearing that the Walnut Fork bridge might be unsafe, ordered out an engine from Terre Haute to cross it for a test. Five men were on the engine which started across the bridge, and, when in the middle, forty feet above the raging river, the engine, without warning, plunged through the weakened structure into the river.

Three of the men were instantly killed, and the other two received injuries that may prove fatal. The killed are: Charles E. McKinzie, brakeman; R. B. Fowler, conductor; John Heiber, fireman. The injured are: J. S. Brothers, roadmaster, three ribs broken and otherwise injured; Frank Bowman, engineer, injured internally. A passenger train from Chicago was only ten minutes behind the ill-fated engine, and, had the roadmaster not ordered the testing of the bridge, the loss of life would undoubtedly have been great. The five railway men sacrificed themselves to save many."

It seems a most needless sacrifice, and respect for the bravery of the victims must temper, but cannot silence, criticism of the foolhardy act. Did the roadmaster conceive it his "duty" to devote himself and his companions to death, to wreck an engine, destroy a bridge, and tie up the traffic of the road, in order to prove the bridge unsafe?

If this is the best method of providing a "test" which is at the command of railroad officials, we had better throw experience to the dogs and burn our text-books. If nothing but absolute demonstration of the bridge's weakness, by testing to destruction, could prevent the passenger train from Chicago from crossing the structure, the engine might at least have been sent over alone, to the saving of agony to the dead and the living mourners.

No doubt the full expectation was that the bridge would stand; it is not conceivable that the roadmaster would have deliveratedly undertaken a course which he believed would destroy it; but it was his clear duty so to arrange his "test" that no disaster would have ensued, whatever the conditions which the test determined.

The Growth of the Trolley.

THE street-railway statistics of the United States, as compiled by the *Street Railway Journal*, display the rather remarkable extent (considering the comparative youth of the electric-railway system) to which the trolley has replaced all other forms of motive power for street-railway traction.

Out of a total of 14.470 miles of such railways in the United States, 12,113 are electrically equipped; the cable, a much older institution, is used on but 599. Dummy engines furnish the power on 519 miles, and 1,219, or a little over 8 per cent., still depend on horse power.

In Canada the proportional conversion to electric traction is even more complete, —450 miles out of a total of 462 use electricity. Indeed, any one guessing at the figures from preconceived opinion alone, without a knowledge of disturbing conditions in the shape of local legislation, would find many surprises.

The eastern States, for instance, have the largest mileage of horse-car lines of any group,—414 miles out of 4,634. New England retains but 88 miles out of 1,823, and the central States but 210 out of 4,600. The non-progressive appearance of the eastern States' figures is due to New York's 295 miles of horse-car lines out of 1,904 miles in the State. Pennsylvania, notwithstanding its proverbial reputation for staid conservatism, has but 10 miles of horse lines in a total of 1,491.

New York and Pennsylvania stand first and second in total mileage; Massachusetts, with 1.153 miles, is nearly tied for third place by Ohio with 1,135; Illinois comes fifth with 1,060,—hardly enough, one would think, for the suburbs of the great city to which the State is annexed.

At the foot of the list is Idaho, with 4 miles—but all electric; South Dakota stands second with 17; and Mississippi, with its much older settlement, can exhibit only 20.

A much better idea of the surrounding conditions is afforded by a comparative study of capital liabilities. The effect of expensive city construction is immediately manifest in the roads operating in densely-settled districts.

The roads of New York State, for example, have capital liabilities of $182,800 per mile, while in Florida the figures are but $7,000.

Taken in groups, the order is: the eastern States, with an average of $147,-300 per mile of track; the central States, with $86,600; the western States, with

$61,100; New England, $54,500; and the southern States, $48,000.

The surprising thing, perhaps, is the position of the New England States as next to the lowest in capital liabilities. Massachusetts, which might be expected to raise its figures, is, in point of fact, surprisingly low,—only $52,300 per mile. Probably the explanation lies in the proportionately large mileage of track in small towns and along the highways between them.

British Influence in Chinese Railways.

THE IRON AND COAL TRADES REVIEW has recently published a good account of the beginning of railroad construction in China, with a description of the line from Tien-Tsin to Shang-Hai-Kuan, 177 miles long, the most important road now operated in that country.

It is built after British models, with rails rolled at Barrow; the engines, with the exception of one Grant locomotive, are English or Scotch; "American cast-iron wheels have been tried, but the steel-tired European wheels are preferred. All cars are equipped with Janney couplers, the only American detail in the rolling-stock."

And yet the *Review* seems to fear the loss or decrease of British influence. "What with Germans, Belgians, and Americans, all working hard to secure concessions, the English will only hold their own with the utmost care and diligence."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Railroad and Engineering Journals—See Introductory.

*6980. First Principles in Railroad Signalling. Ill. George H. Paine (Describing in detail the various methods of interlocking and block-signalling). Eng Mag-Aug. 5200 w.

*6986. British Railway Stocks as Desirable Investments. William J. Stevens (Answering Mr. Thomas F. Woodlock's arguments against investment in English railroads). Eng Mag-Aug. 4700 w.

6999. Bridges for Electric Railroads. Charles F. Stowell (A review of accidents occurring under the new heavier requirements and an arraignment of inadequate specifications and defective tests). R R Gaz-July 10. 1500 w.

7000. Locomotive Records of the Illinois Central Railroad (A new method of classifying and charting repairs, showing the relation to mileage made and tabulating the condition of power on any division). R R Gaz-July 10. 2400 w.

7001. The Illinois Central Railroad Improvements at Chicago (Detailing the agreement between the railroads and the general plan of the proposed work). R R Gaz-July 10. 1700 w

7002. Statistics of the Railroads of the World (Table giving milage of railroads of all countries, in proportion to area and population; and capital per mile for all important countries). R R Gaz-July 10. 300 w.

7003. Yard Limits (Editorial discussion of the necessity of adequate marks, rules and signals to remove the danger of occupying main tracks with yard work). R R Gaz-July 10. 1400 w.

7004. Demurrage on Freight Cars in England and America (A review of an English decision sustaining individual as opposed to average computation in levying demurrage on cars). R R Gaz-July 10. 900 w.

*7012. South Eastern Railway Engines: Past and Present. W. B. Paley (Historical review with many photographs of early English engines). Ry Wld-July. Serial. 2200 w.

*7013. Hartlepool Electric Tramways. (Decription of the line, power, installation and equipment). Ry Wld-July. 2300 w.

*7014. The New East Coast Corridor Trains (An enthusiastic description of an English approach to the American vestibuled train). Trans -July 3. 2400 w.

*7015. Maximum Legal Passenger Tariffs. London, Chatham and Dover Railway. (A tabular arrangement, with graphic representation of the main line and branches). Trans-July.

7029. Emergency Bridge Construction on the "Big Four" R. R. (Account of very rapid work in the temporary and permanent replacement of a wrecked bridge). Ry Rev-July 11. 1500 w.

7084. The Ithaca Street Railway (A description of a railway system in an ideal situation for the engineer who delights in difficult problems. It is considered a triumph for the electric system of traction). Elec Wld-July 18. 1700 w.

7085. Electric Lighting of Railway Trains in Australia. Daniel W. Maratta (Describing an installation of charging dynamo and storage cells, the method of running and the cost of maintenance). Elec Rev-July 15. 800 w.

*7086. Two Years' Extension and Working of Belgian Light Railways (Some general figures of mileage, capitalization, equipment and passenger and freight receipts). Eng, Lond-July 3. 3000 w.

7095. A Union Terminal for Chicago's Elevated Railways (History of the project, with maps and description of general method of using the loop line). Eng News-July 16. 1100 w.

7096. The New Fast Train Services Between London and Scotland. J. Pearson Pattinson (The service is stated to be remarkable for frequency and speed combined. A table accompanies the article). R R Gaz-July 17. 350 w.

7097. Jubilee of the London & North Western Railway. W. B. Paley (A sketch of the rise and progress of an important English line). R R Gaz-July 17. 1100 w.

7098. Railroad Matters in England. W. M. Acworth (Favorable opinion of the Glasgow Chamber of Commerce on pooling in England, and some notes on English baggage handling. R R Gaz-July 17. 1100 w.

*7099. Railway Block Signalling. J. Pigg (The first part is devoted to statement of some general principles, and the features of certain special signal codes, all based upon British practice). Elec Eng, Lond-July 3. Serial. 1st part. 1700 w.

*7100. Electric Traction: A Review of its Application and a Comparison with Other Methods. R. St. George Moore (A paper before the Inst. of Civ. Engs discussing traction, line and power from the civil engineers' point of view and by examination of prominent examples). Elec Eng, Lond-July 3. 2800 w.

*7117. Pringle and Kent's Surface Rail Electric Railway (Describing an English system proposed to replace the trolley, at a moderate increase of cost). Elec Rev, Lond-July 3. 2000 w.

7130. Discipline Without Suspensions (Results of the use of the Brown system of discipline on the K. C. F. S. & M. Ry. (The results described are highly favorable to the system, even under adverse circumstances). Ry Age-July 17. 900 w.

7131. Traveling Engineers or Road Foremen? (An argument for giving traveling engineers authority in the operating department). Ry Age-July 17. 800 w.

*7134. The Summer Train Services (An exposition of modern English passenger service as developed by the rivalry of the East and West Coast lines). Engng-July 10. 1600 w.

*7136. The Central London Railway (History of an underground electric traction line on which work is to be begun at once, with notes of other pending schemes). Eng, Lond-July 10. 1600 w.

*7139. American and British Permanent Way (Editorial, arguing the superiority of English practice). Eng, Lond-July 10. 1500 w.

*7140. Mechanical Fog Signalling (Editorial discussion of fog signal requirements and the respective merits of human and mechanical agencies). Eng, Lond-July 10. 1600 w.

*7145. Three Phase Electric Railway at Lugano, Switzerland (Reviews the advantages of the multiphase system and solutions of objections made, and gives a description of the first street railway built under the system). St Ry Rev-July 15. 2000 w.

*7146. Tests of Heavy Motor Cars on the Buffalo & Niagara Falls Electric Railway (Giving graphic representation of results of friction, traction, acceleration and electrical tests). St Ry Rev-July 15. 900 w.

*7147. An Important Pole Decision (Upholds an ordinance permitting the use of poles against the objection of an abutting-property owner). St Ry Rev-July 15. 3000 w.

*7148. Paris Street Railway Notes. Charles N. King (The notes are concerned chiefly with the working of compressed air and steam (Serpollet) motors). St Ry Rev-July 15. 1500 w.

*7149. The Washington, Alexandria & Mt. Vernon Electric Railway (Describes a device for changing from underground to overhead trolley). St Ry Rev-July 15. 600 w.

†7158. Light Railways (A review of Mr. R. J. Money's paper before the Inst. of Civ Engs. is made the basis of a discussion of gauge, favorable to the retention of standard gauge, or to slight reduction only). Ind Eng-June 6. 1100 w.

*7159. Electrical Locomotives — Systéme Heilman (A sharp criticism of the engineering conceptions embodied in the construction). Elec Rev. Lond-July 10. 700 w.

*7161. Traction Diagrams. Thomas Tomlinson (The first part criticises the general insufficiency of data accompanying traction diagrams, and discusses such diagrams from the points of production, interpretation and utility). Elec Rev, Lond-July. Serial. 1st part. 2000 w.

†7164. Mexico: Tehuantepec Railway and Vera Cruz Harbor Works (Historical sketch of the undertaking and announcement of an important new contract for its completion and operation). Ind & East Eng-June 20. 2500 w.

†7165. The Siberian Railway (Sketch of the route, engineering features and progress of work on the line). Ind & East Eng-June 20. 1700 w.

7181. Development of the Railroad Facilities of New Orleans, and the Proposed Double Track Railroad Bridge over the Mississippi River. E. L. Corthell (Reviews the expansion of commerce in New Orleans consequent upon Ead's work, and the necessity for railroad facilities in proportion, and sketches the bridge project). Mfrs' Rec-July 17. 5500 w.

7183. Illinois Central Railroad (Historical and descriptive account of the road and its territorial relations). Mfrs' Rec-July 17. 5800 w.

7196. Street Railway Repair Accounts. C. F. Uebelacker (Advocates and illustrates a system of records designed to secure economy and increase efficiency in repair department). Elec Wld-June 25. 2000 w.

7197. Powers Over Street Railways. R. D. Fisher (A discussion of franchise limitations and municipal rights of control, and a plea for the simplification of street railway law). Elec Wld-July 25. 800 w.

7206. Automatic Signals on the Boston and Albany. George W. Blodgett (Describing the initiation and gradual development of a comprehensive system, with general considerations on the choice of a system and the incalculable value of signalling). R R Gaz-July 24. 2000 w.

7207. The Minimum Dimensions of a Rail

(Results of tests showing that the least thickness ever given to webs in practice is much more than sufficient to safely stand the strains and shocks of railway service). R R Gaz–July 24. 800 w.

7208. Municipal Ownership of Street Railroads (Abstracts of speeches by Charles Richardson favoring, and by Frank M. Loomis opposing ownership, both delivered before the National Municipal League of Baltimore). R R Gaz–July 24. 2300 w.

7211. Train Accidents in the United States in June (Classified table with explanatory comment). R R Gaz–July 24. 2200 w.

7212. Track Laying in the First Six Months of 1896 (A detailed statement by states and railroads). R R Gaz–July 24. 1200 w.

7219. Railroads and Bridges (Reviews the rapidity and proportions of the growth of the railroad in America, the daring engineering in its development, etc. Illustrates and describes noted railroad bridges crossing rivers, ravines and canyons). Sci Am–July 25. 3200 w.

7226. The American Locomotive (Historical sketch of its development since 1829, with photographs of typical engines). Sci Am–July 25. 2000 w.

7240. Rules for Loading Long Structural Material on Railway Cars (Report of committee of Master Car Builders' Assn., submitted to letter-ballot for adoption. The methods are illustrated by diagrams). Eng News–July 23. 3500 w.

7242. The Arrangement and Construction of Railway Shop Plants (Considers generally the location, arrangement, architecture, and equipment of buildings). Eng News–July 23. 2500 w.

7243. The Cubic Parabola as a Transition Curve for Street Railways. Jenks B. Jenkins (An example of its use as a solution of a difficult problem in Pittsburg, given to illustrate the practice, with formulas for determining minimum clearance in any curve and smallest radius to which the curve is applicable). Eng News–July 23. 500 w.

*7277. A New Electric Railway in the Isle of Man (Describes the line, construction and equipment of a scenic road). Elec Rev, Lond–July 17. 2000 w.

*7278. Trials of An Express Locomotive. William Adams and William Frank Pettigrew (Abstract minute of Pro. of Inst. of Civ. Engs. Giving the results of five tests of an English locomotive, with indicator diagrams and charting showing speed, boiler pressure, vacuum and air pressure, smoke box temperature and indicated horse power). Ind & Ir–July 17. 1700 w.

*7298. The New Train Services. Charles Rous-Marten (Describes with considerable detail, typical modern English fast-passenger service). Eng, Lond–July 17. 2500 w.

*7301. Gas-Motor Tram Cars (Illustrated description of these cars recently put in operation by the Blackpool, St. Anne's, and Lytham Tramways Co). Eng, Lond–July 17. 1000 w.

*7302. Locomotive Building in Japan (Facts about this engine, which was reported to have been constructed at much less cost than could have been possible in England). Eng, Lond–July 17. 1400 w.

*7341. Brazil Railways and Shipping (Contains data of lines operated, under construction, and projected, and of the unprofitable operation of existing railways). Trans–July 17. 500 w.

7342. Railroad Pooling. Martin A. Knapp (An address delivered before the Political Economy Club of the University of Chicago. The first part treats of the general relations of railways, the principles involved in pooling, and the abuses which would be checked by its influence). Ry Rev–July 25. Serial. 1st part. 4000 w.

7343. Traveling Engineers—Their Duties and What They May Accomplish. C. E. Slayten (Read before the North-west Railway Club. Discusses the work of the traveling engineer in great detail, and strongly recommends the extension of his authority with the operating department). Ry Rev–July 25. 2500 w.

7344. The Cost of Air Brake Rigging (Reviews the recent discussion arising from Mr. Parke's criticism of railroad shop expenses, and gives tabulated figures for a 36-ft. car rigging, with cost and weight, from actual practice). Ry Rev–July 25. 1200 w.

7345. Acetylene and Car Lighting. P. H. Conradson (Abstract of paper read before the North-west Railway Club. Reviews briefly the manufacture and use, and gives comparative illumination and cost of oil, carburetted air, Pintsch gas, electricity and acetylene). Ry Rev–July 25. 1800 w.

7371. Abstract of Statistics of the Railways of the United States for the Year ending June 30, 1895 (An advanced abstract of the forthcoming Eighth Annual Statistical Report, giving condensed statements of mileage, equipment, capitalization, earnings, expenses, etc). 2500 w.

7272. Freight Yard at Dresden, Germany (A noteworthy instance of time economy secured by proper laying-out and gravity switching, with some notes on sand track). R R Gaz–July 31. 800 w.

7374. Underground Electric Road in Budapest (Brief description of construction, operation, and equipment; with sectional drawings). R R Gaz–July 31. 700 w.

7375. The Logan Collision (Editorial reviewing the accident as an argument for the block system). R R Gaz–July 31. 1600 w.

†7378. The System of the Consolidated Traction Company of New Jersey (A full detailed description of power plant, equipment, permanent way, operation and discipline: with complete data, illustrations, table, map of the lines, etc. Also editorial). St Ry Jour–Aug. 7000 w.

†7379. The Electric Railway System of Rouen (A brief summary of the system and equipment). St Ry Jour–Aug. 500 w.

†7380. Some of the Rights of Street Railways in the Highway (A tabulated summary of decisions in questions of franchise, liability for accidents, etc). St Ry Jour–Aug. 2000 w.

†7381. Recent Electrical Overhead Work in San Francisco. S. L. Foster (The work is

notable for substantial construction and generous dimensions). St Ry Jour–Aug. 1800 w.

†7382. Car Specifications (Standard specifications of Consolidated Traction Co. of New Jersey for 20-ft. box cars). St Ry Jour–Aug. 1800 w.

†7383 Statistics of Mileage, Cars and Capitalization of American Street Railway Properties (The statistics are given in very clear tabulated form, with brief comment). St Ry Jour–Aug. 1000 w.

*7385. The Preservation, Maintenance and Probable Durability of Rolling Stock with Metal Underframes and Metal Upperframes. M. L. Tower (Translated from the *Revue Génerale des Chemins de Fer*. Describes a most careful investigation of the wear and corrosion in cars built since 1861. Metal upperframes are not found to increase the life of the car. The metal underframes are given a life of 50 to 60 yrs. With editorial). Am Eng & R R Jour–Aug. 5000 w.

7391. A Right Way and a Wrong Way to Place Compressed Air in Competition with Electric Power for Street Railways. R. A. Parke (Discusses economy in compressing and criticises strongly the effort to secure long mileage between changings, by using very high storage pressures). W Elec–Aug. 1. 1400 w.

7399. The New York and Queens County Electric Railway. J. E. Woodbridge (Describes briefly the line, power plant and equipment with photographs and diagram of car wiring). Elec Wld–Aug. 1. 900 w.

7400. The Hardie Compressed Air System (Description with quite full data of the plant at Rome, N. Y., and compressed air car, with a few notes of speed and traction performance). Elec Wld–Aug. 1. 2000 w.

*7429. Permanent Way. W. Lawford (Urges the extreme importance of good ballast and good ballasting). Eng, Lond–July 24. 2000 w.

7459. Third Rail Conductors. Leo Daft (Illustrated account of a few experiences with third rails as conductors). Elec Eng–Aug. 5. 1200 w.

7461. The Trolley Base Suit (Decision just rendered by the Circuit Court of Appeals in New York, involving the manufacture and use of trolley bases. Opinions in full, with editorial). Elec Eng–Aug. 5. 4200 w.

7462. Accident to An English Racing Train (Comments on the curious change of attitude of the British press on account of an accident, and questions whether high speed is objectionable on any other ground than that of economy). Ry Age–July 31. 900 w.

7463. The Pooling of Freight Equipment, J. R. Cavanagh (Read before the Assn. of Ry. Officials at Toledo, O. Some practical suggestions as to how to do it). Ry Age–July 31. 1900 w.

*7464. Staybolt Seating Machine. John Randol (Describes the construction and operation of an excellent special device, with illustrations). Loc Engng–Aug. 2000 w.

*7465. Steel Cars—Norfolk & Western Railway (Description, general construction, with partial detail drawings). Loc Engng–Aug. 800 w.

*7466. Rules for Calculating and Designing Driver-Brake Gear of the Push-Down Type (Gives general formula and examples of application to special cases). Loc Engng–Aug. 500 w.

*7467. Air-Brake Practice on the Fitchburg Railroad. H. S. Kolseth (Describes a method adopted with excellent success, for increasing the efficiency of engineers in handling the air-brakes). Loc Engng–Aug. 900 w.

7468. Stations of the Union Elevated Loop, Chicago (Description with sectional drawings and elevations). Ry Rev–Aug. 1. 1200 w.

*7469. The Railways of India (A review of mileage, traffic and earnings. which last are said to be very satisfactory). Trans–July 24. 1100 w.

7487. The Grade Crossing Collision at Atlantic City (Account of the circumstances in connection with the disaster gleaned from various sources, with editorial comment and suggestions). Eng News–Aug. 6. 3300 w.

*7542. Chinese Railways and British Trade (Description of the history, present construction, operation, cost, engineering features, and projected extensions, with some notes of prevailing foreign influences). Ir & Coal Trds Rev–July 31. 1000 w.

7545. On the Measurement of the Insulation Resistance of Street Railway Cables. Edwin J. Houston and A. E. Kennelly (Describing a method which is said to eliminate the usual difficulties experienced in testing underground cables). Elec Wld–Aug. 8. 1000 w.

7546. The Syracuse Street Railway (A short illustrated description of the power plant and equipment). Elec Wld–Aug. 8. 1000 w.

*7547. The Railways of India (A review of the finances of the India roads; their earnings and expenses; and a summary of recent and current construction). Trans–July 31. 1800 w.

†7548. Administration Report on the Railways in India (A review of the government report, with explanation and critical comment). Ind Engng–July 4. Serial. 1st part. 1300 w.

7558. Suspensions Abolished on the Southern Pacific (Description and illustration by example of a new system of discipline). R R Gaz–Aug. 7. 1600 w.

7559. Track Elevation on the Milwaukee Division of the Chicago and Northwestern Railway (General description of the proposed work, with quantities of materials involved and methods of work adopted). R R Gaz–Aug. 7. Serial. 1st part. 1100 w.

7560. The Atlantic City Collision (Editorial, using the accident as a text for a discussion of safety measures at grade crossings). R R Gaz–Aug. 7. 1200 w.

*7562. The Lührig System of Gas-Motor Tramway Cars. G. Grosch (Brief description of a system said to be in successful operation in Dresden). Ind & East Eng–July 11. 600 w.

SCIENTIFIC MISCELLANY

The Sea Mills of Cephalonia.

We venture to say that many of our readers are not even aware of the existence of a singular phenomenon, described in *Technology Quarterly* for March by Mr. F. W. Crosby and Mr. W. O. Crosby jointly,—a phenomenon that has never been satisfactorily explained, unless the plausible explanation offered by the authors of this very interesting paper may now be accepted as sufficient. A natural curiosity not generally mentioned in books describing the Grecian possessions, but one which has occasionally excited the curiosity of travellers, is located at a point on the coast of the Island of Cephalonia, one of the Ionian group. Here an unintermitting current of sea water flows into the land for a distance of about fifty yards through an artificial channel, and then plunges down into clefts and fissures, and disappears. The current is quite uniform, and is not the result of tidal action, since the rise and fall of the tides at the point named is very slight. A quotation from Baedeker's "Greece" introduces the description of this singular current, as personally observed by one of the authors of the paper reviewed.

"From the Maitland Monument we may proceed along the coast, past the British Consulate and the large wine-cellars of Mr. Toole, to the celebrated Sea Mills. The first of the latter is the mill of Dr. Migliaressi, established in 1859, and one-fourth mile farther on, at the north end of the peninsula, is the old mill, erected by Mr. Stevens in 1835, where we obtain a better view of the phenomenon from whence the mills derive their name. The mills are driven by a current of sea-water, which flows into the land for about fifty yards through an artificial channel, finally disappearing amid clefts and fissures in the limestone rock. Authorities are not yet unanimous as to the explanation of this unique phenomenon."

Incredulous as to the accuracy of this (Baedeker's) account, which seems out of accord with natural laws, Mr. F. W. Crosby visited Argostoli to see for himself.

"A mile north of the town, at the extremity of the promontory and the mouth of the harbor, are the Sea Mills. The entire promontory is composed of the ordinary bluish white Secondary limestone. It is nearly destitute of soil and vegetation, and the surface is very rough and ragged from unequal weathering. The land is low and flat at the north end in the vicinity of the mills, but it gradually rises as it trends southward, and between the town of Argostoli and St. George's Castle, five or six miles distant, attains a height of two hundred to three hundred feet or more. Although Mr. Stevens, in 1835, was the first person to utilize this anomalous water power, the existence of the running water had long been known to the natives without exciting any special interest in their minds. The mills have not been running for years, and are now in a state of dilapidation and decay. Each race, or flume, is continued for a few yards beyond the mill, and terminates in an irregular pit excavated to a depth of three to five feet below the sea-level. From this discharge pond, as it might be termed, the water rapidly disappears through numerous narrow openings,—seemingly enlarged joint fissures. The races have a breadth of four to six feet, and the bottoms slope inland sufficiently to insure a strong current at the mills. The wheels in both mills were of the undershot type, of rough country make, and connected by means of equally crude gearing to the millstones within the mill.

"The only difficulty experienced in operating the mills was to prevent the ingress of seaweed and other trash which would choke up the discharge vents. At the Stevens Mill gratings were used for this purpose, but occasionally the crevices in the rock had to be cleaned out, as more or less weeds would get through the grating. Dr. Migliaressi, at the new mill, improved upon this by building a walled inclosure about forty feet square in the sea, around the mouth of the flume leading to his mill. The wall, being laid without cement below the surface of the water, gave access to the water, but kept out the obstructing seaweed. In all other respects the mills were practically alike."

The influx of water described extends along the coast for about a half mile. "The water is everywhere percolating through the cracks and fissures of the limestone and sinking into the earth." Mr. Crosby estimates that not less than four thousand cubic feet per minute thus disappears, and he very justly supposes that the hypothesis of a cavern receiving this amount of water hourly for a century or more must be of a size very far exceeding any existing cavern known. He therefore rejects this hypothesis altogether for an explanation which he thinks may fit the facts, and which is certainly much more acceptable than the cavern hypothesis.

The authors have been unable to find any reference to this subject in any strictly scientific work, except an account of it given by Mr. H. E. Strickland, an English geologist, who observed it in 1835, and described it in a treatise published shortly afterward. He believed that the water entering the fissures was subsequently evaporated by currents of air upon the surface of the land and circulating through innumerable fissures in the rock, the latter acting very much like a sponge exposed to air and sun at the top, and to inflowing water at the base. In consequence of this evaporation, the water in the caverns would always be lower than in the sea, and hence the water would flow in through the open fissures.

If evaporation is thus going on through long periods, it seems that a constant deposit of salt must occur in the fissures, and this would probably terminate the action by stopping up the passage, were it not that frequent earthquakes occur in this region, causing new fissures. Mr. Strickland held the opinion that large deposits of salt were thus forming in the caverns, and he quotes Professor Ansted as having estimated the rate of deposit from the evaporated sea water as annually not less than 1,800 cubic yards. It is, however, a singular fact, in connection with this hypothesis, that there are no springs on the island that contain any notable amount of salt. Clearly, such a deposit as this could not have been progressing during a century without very largely obstructing the inflow of water by filling up fissures, or without charging springs with saline matter. The difficulties in accepting evaporation as a sufficient explanation are therefore so great that it will probably be rejected by most scientists.

For the theory of evaporation the authors of the paper under review substitute a mechanical theory which seems more plausible, yet which is also not exempt from difficulties. If a bent tube be filled with water and set so that its open ends are both at the same level, and if one of the branches above the lower part of the tube be heated, water will temporarily flow out of the upper end of the heated branch; and, if the open end of the cooler branch be so arranged that water can constantly flow into it, circulation will be set up toward and through the hotter branch, which will constantly dischareg as much water as flows into the cooler end. Such a circulation would take place with the end of the heated branch somewhat higher than that of the cooler branch, the difference in height depending upon the temperature maintained in the warmer branch as compared with that of the cooler branch, and the consequent difference thus created in the specific gravities of the two water columns. A U-shaped tube, with its open ends inserted through and soldered to the bottom of an open basin containing water, would, upon warming one of the branches, well illustrate this action, for which, also, an analogy may be found in hot-water heating apparatus for warming buildings, and in some constructions of water-tube boilers. Such an arrangement may be conceived as typifying the state of things at Argostoli. Water flowing down one branch of a fissure may, by becoming warmed in another branch, be caused again to ascend, and thus a continuous flow would be established. The internal heat of the earth is supposed to maintain this action. The fact that seismic phenomena are of frequent occurrence in the Ionian islands lends plausibility to this assumption.

Tornadoes and their Causes.

TAKING as a text the great damage done in St. Louis by the tornado of May 27, *Engineering* (July 3) states editorially the conditions which preceded the storm, regarding these conditions as conforming to the laws of such storms "so far as they are understood." The saving clause quoted is of some importance, for, the more the subject is studied, the more the mind of the student will be forced to admit mysteries connected with tornadoes that scientists have not yet been able to penetrate. To speak of law in phenomena, each of which has exceptional characteristics when referred to the so-called law, seems hardly logical; yet there are some features in the genesis of these storms which seem to be uniform. The weather bureau reports show that "cold winds were blowing from the north and northwest, and that warm southerly winds met the cold currents in the near vicinity of St. Louis."

We know experimentally some of the results of mixing warm, humid air with colder air. Condensation of moisture always occurs. Depending upon the difference of temperature in the bodies of air which thus meet and upon the rapidity with which they commingle, the condensed moisture takes the form of clouds, rain, snow, or hail. But tornadoes do not always result from the meeting of such currents. Usually, however, there are high winds. Evidently the production of a "twister," such as is a too familiar phenomenon in the west, involves something more than the meeting of two air currents having widely different temperatures.

Professor William Blasius, about the middle of the century, made a study of tornadoes. The conclusions he arrived at seem to have been accepted without question by *Engineering* in the article under review. He believed that the primary condition for the genesis of a tornado "is the encounter between polar and equatorial currents, which, just prior to the outbreak, balance each other along their line of meeting, compressing the air beneath and causing the extreme sultriness that precedes the outbreak. It may, and does sometimes, happen that the effects of the collision are averted by a sudden change in the direction of the air currents; but if, as is usually the case, some local disturbance occurs, the heavier and colder air from the north will sink, causing a depression above into which the warmer air from the south then rushes violently, and, with a change in its direction, produces an eddy, the commencement of the tornado. The appearance of a circular whirling cloud, produced by rapid condensation, is the first indication of the approaching crisis. As the transposition of the colder and warmer volumes of air continues, the cloud grows darker and larger, at the same time descending in funnel shape towards the ground. The outside of this rapidly-revolving cone rises in temperature on account of the latent heat set free by condensation, while within the temperature is lower because of the rarefaction produced by centrifugal force. Blasius says, in reference to this stage of the storm:

"When the tornado-cloud has approached the ground, the surrounding air on the surface will rush into the space of rarefied air of the vortex with a velocity proportionate to the difference of pressure outside and inside the mass. This current will be made visible by a mass of detached objects, such as sand, dust, or water, which it whirls up off the ground. Thus a second cone, looking like a cloud, with its base on the earth, will be attached to the inverted cone of the tornado-cloud, which has its base in the cumulo-stratus of the south-east storm.

The path of the tornado is comparatively limited; it seldom exceeds twenty miles in length and six hundred yards in width. The form of the rapidly travelling and revolving cone of cloud varies constantly. It is described by eye-witnesses as taking a zigzag forward motion, and as rising and falling,—many comparing it in form and lateral movement to an elephant's trunk. In 1851 there was a famous tornado at Cambridge, near Boston, Mass., almost as violent as the recent one at St. Louis, though destructive only to the trees and scattered houses that lay in its path The phenomena were closely watched by many observers. One witness said: "It seemed to act on a building as a mill grinds whatever is put into it. If every square foot of atmosphere in the column had been armed with a steel tooth, and the buildings and trees which went into it could have passed through it, it could not have shivered them to smaller pieces. . . . It seems as if a vacuum had travelled (if we can say so) fifteen or twenty miles from west by south to east by north, and the wind had rushed in with violence, not only behind it, but on each side towards its central line of motion, prostrating the trees in the manner above stated."

Now, it is easy to show that the primary condition, named by Blasius, is by no means the only condition; were it such, its establishment would be invariably followed by a tornado. As a matter of fact, tornadoes, in the majority of cases wherein this primary condition exists, do not follow. Such storms are occasional and exceptional. A description of what was seen at St. Louis before the storm burst is interesting in this connection.

"The conditions of temperature and humidity had been quite abnormal for several days prior to the fatal Wednesday. About noon of that day the barometer commenced falling, and the sky was covered with cumulo-stratus clouds, reversed in form; these gradually took a regular stratified position, and in the northwest assumed a vivid green hue. At 4 P. M. thunder and lightning commenced at 4.30 rain fell heavily; and at 5 the storm burst out in full fury, rushing with great rapidity at first from north-west towards south-east, and changing its direction later.

At 5.15 P. M. the wind blowing from the north-west was credited with a velocity of eighty miles an hour, and during ten minutes, from 5.20 to 5.30, the barometer fell to 29.35. This completed (about 5.15) the first period of the storm, but not the disastrous period. It was accompanied by the long cone cloud descending towards the ground, and by an extraordinary electrical display.

"Against a background of various tints of green, forks and sheets and luminous balls of fire, colored purple and red and blue, shot out, accompanied by roars of thunder. All the while to the south the sky remained bright and nearly clear. During the second period, lasting about twenty minutes, nearly all the destruction was wrought. The great velocity of the wind had abated, and rain fell in torrents; between 5 and 9 P. M. 3.04 in. were measured. But during the short crisis those who made the experience were able to realize to some degree the illimitable power of the forces of nature. The clouds descended to the housetops, wrapping the city in darkness, except for the lightning. The irresistible power of the cloud vortices swept everything from their path, uprooting trees and twisting around large trunks that proved too resistant, transporting wagons and horses, levelling buildings, and turning everything in the line of the storm to nearly universal ruin. The vast network of wires that almost obscured the light in the streets of St. Louis added to the destruction and the horror of the scene. In every direction the long lines of telegraph poles were flashing pillars of blue flame. The wires were strings of fire, and the insulators were blazing bunches of sizzling wires."

The evidence that electricity was one of the forces concerned in this storm is most conspicuous in the description we have quoted. "At 4 P. M. thunder and lightning commenced." When the long coned cloud formed, "forks and sheets and luminous balls of fire, colored purple and red and blue, shot out, accompanied by roars of thunder," constituting what may be truly called "an extraordinary electrical display." Further, "the telegraph poles were flashing pillars of blue flame," and "the wires were strings of fire." Now allowing much for rhetoric in these descriptions, it is impossible to disregard the fact that a violent electrical discharge of energy was going on when this storm reached its climax, and that some of the effects produced can be more readily accounted for by referring them to electricity than by the supposition that the *vis viva* of air currents was their sufficient cause. When, if ever, the true inwardness of tornadoes becomes known, electricity will doubtless be recognized as at least one of the most potent forces concerned in them.

Helium and Argon.

THE obstinacy with which these two newly-discovered chemical elements refuse to combine with other substances is confirming the belief that they are what chemists style non-valent,—that is to say, in no proportion are they capable of entering into combination with other substances. If so, they will add another argument to those already brought forward against universal design in nature. If these substances react with no other substance, what use or design can they possibly subserve in the universe? *Nature* (June 11) gives an abstract of a paper by Prof. William Ramsey and Dr. J. Norman Collie, read before the Royal Society (May 21), in which these eminent scientists record the efforts they have made to obtain reactions with substances deemed the most promising, and state their entire failure. "The plan of operation was to circulate helium over the reagent at a bright red heat, and to observe whether any alteration in volume occurred—an absorption of a few c. c. could have been observed—or whether any marked change was produced in the reagent employed. As a rule, after the reagent had been allowed to cool in the gas, all helium was removed with the pump, and the reagent was again heated to redness, so as, if a compound had been formed, to decompose it and expel the helium. Every experiment gave negative results; in no case was there any reason to suspect that helium had entered into combination." Sodium, silicon, beryllium, zinc, cadmium, boron, yttrium, thallium, titanium, thorium, tin, lead, phosphorus, arsenic, antimony, bismuth, sulphur, selenium, and uranium oxid were some of the substances experimented with. Argon and carbon do not react even under prolonged heating. Chlorine and helium exposed to silent electrical discharge for several hours remained unchanged. Helium is not absorbed by cobalt powder at red heat, and platinum black, a most energetic absorbent of other gases, does not occlude it.

Among other experiments induction sparks passed through a mixture of helium and benzine vapor for many hours produced no effect upon the helium, though the benzine vapor was altered in the same way as it would have been had nothing but benzine been present. We have, therefore, now in the catalogue of chemical elements, two which appear entirely inactive, and therefore useless in the economy of nature.

Minerals Associated with Burmese Rubies.

IN *Philosophical Transactions* is presented an account of some minerals collected by Mr. C. B. Brown while carrying out, under orders of the secretary of State for India, an investigation of Burmese ruby mines.

Details are given, with maps, of the physical geography and geology of the region and the rude processes employed by the natives in mining the gems. They are for the most part washed out of alluvial material filling hollow basins and clefts in a limestone rock, but their original situation, as proved by Mr. Brown, is in the rock itself. This is a hard, crystalline limestone interbedded with gneiss, and by breaking some of it to fragments Mr. Brown obtained in ten days fourteen rubies from one and a half cubic feet. These were, of course, injured much by the jarring necessary to break up the stone, but they showed that by better methods the gems could be obtained in larger quantity.

Prof. Judd says: "The limestone which the rock in Burma most closely resembles is undoubtedly that of Orange Co., N. York, and Sussex Co., N. Jersey, which is associated with the remarkable deposits of zinc ore at Franklin Furnace. The general conclusion to which we have been led concerning the origin of the rubies of Burma is as follows: Pyroxene gneisses abound with an unstable basic feldspar, which is easily converted by minute quantities of hydrochloric acid under pressure into a scapolite, this in turn breaking up into various hydrated aluminum silicates and calcite." *Amerienn Geologist* says, with reference to the formation of rubies, that, while the limestones are being formed from basic feldspars, the aluminum silicates, taking up water, may be attacked by sulphuric, hydrochloric, boric, or hydrofluoric acid at moderate temperature and decomposed, the aluminum oxid, in some cases anhydrous, being formed, which may assume the crystalline form. The presence of carbonic acid in the liquid state in some of the cavities indicates formation under great pressure.

Ductile Cast Iron.

WE are hearing something of a new material turned out by a company in East Chicago, and find in the *Iron Age* a statement in regard to it. It is said that castings of this metal (called ductile cast iron) as large as ten thousand pounds can be made, and the claims further put forth are very remarkable. The castings are said to be homogeneous, free from blow-holes, may be drawn under hammer, perfectly welded, and are workable, like wrought iron, by machine tools. Tests of the metal have, it is alleged, shown it to possess a tensile strength of from 63,000 pounds per square inch to 80,000 pounds.

Iron Age says that, "after being heated to a dull red and plunged into cold water, the metal can be cut easily with a file, showing that it takes no temper. Specimens of castings are shown which have had portions heated and drawn out flat under the hammer, afterward being twisted cold and pounded flat, without a sign of fracture. Gates from castings are shown which have stood remarkable torture of this character. A notable piece of work is a heavy chain, of which the links were cast open, then joined, and the open spaces welded without the use of flux. Valve stems, crank shafts, and other similar pieces are shown, which have been finished to pattern in a lathe, exhibiting a smooth surface without a suspicion of a blow-hole. Intricate castings are exhibited which have been reproduced regularly without a failure, while a very high percentage of losses has been reported when made by other methods of producing very strong castings."

It is said to be the intention of the company "to meet the demand for castings of the highest grade, competing with drop forgings, and aiming to produce shapes which are difficult to work under a hammer, but for which castings have heretofore not been found sufficiently strong and trustworthy." The castings are also said to be "well adapted for electrical apparatus, owing to their high conductivity."

THE *Engineering and Mining Journal* says that Madagascar is an exceptionally good field for mineral prospecting, so far as the natural conditions are concerned. The climate of the interior plateau is good, and in the mountains (9,000 to 10,000 feet) even cool, though on the coast it is hot. There is plenty of timber and water, but transportation is thus far in a primitive stage.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Scientific and Engineering Journals—See Introductory.

6988.—75 cts. The Sea Mills of Cephalonia. F. W. Crosby and W. O. Crosby (Excellent description and attempted explanation of a very singular phenomenon which has been observed many years hitherto without satisfactory explanation). Tech Quar–March. 7500 w.

6990.—75 cts. Reduction of Nitrates by Bacteria and Consequent Loss of Nitrogen. Ellen H. Richards and George William Rolfe (Interesting experiments which lead to the conclusion that bacteria are active agents in the disappearance of nitrogen in nitrogen-compounds dissolved in water). Tech Quar–March. 3600 w.

6991.—75 cts. The Graduation of a 100-Inch Photometer Bar. W. Lincoln Smith (Presents a table of scale readings in inches and corresponding ratios of unknown to standard which, when multiplied by the value of the standard in candle powers, gives directly the value of the unknown. Also explains the method by which the table has been obtained). Tech Quar-March. 350 w.

*7007. The Tornado at St. Louis. Ill. (Conditions for the genesis of storms of this character). Engng-July 3. 1700 w.

*7024. Individuality in the Mineral Kingdom. Henry A. Miers (An inaugural lecture delivered at the University Museum, Oxford, Eng. An interesting address). Nature-July 2. 6000 w.

7036. The Standing of Engineering Among the Professions. J. S. Kreerl (Read before the Montana Soc. of Civ. Engs. A discussion of the fitting recognition of the engineering profession). Arch & Build-July 11. 1200 w.

7037. Asbestos. George Heli Guy, in *New York Evening Post* (What it is; where found; the process of manufacture; its uses). Arch & Build-July 11. 1800 w.

†7062. The Contractor's Fair Profit. John H. Burnham (Consideration of what is a fair profit, with discussion). Ill Soc of Engs & Surv-11 An Rept. 4200 w.

7070. Röntgen Ray Tubes. Elihu Thomson (Criticising some statements made in articles appearing in this paper, and illustrating various forms of tubes). Am Elect'n-July. 800 w.

7075. The State of the India Rubber Supply. Hawthorne Hill (Showing that there is little fear that the price of rubber will be increased materially in the future). Elec Eng-July 15. 1800 w.

7078. Emission of New Radiations by Metallic Uranium. Henri Becquerel, in *Comptes Rendus* (Study of these salts with results of scientific interest). Elec-July 15. 900 w.

7079. On Hyperphosphorescence. Silvanus P. Thompson, in *Philosophical Magazine* and *Journal of Science* (Explains why the writer gives this name to the new phenomenon observed by M. Becquerel and by himself). Elec-July 15. 600 w.

7119. Decimal Numeration in the United States. E. E. Slosson (The use of it is regarded as on the increase, and the author appears to anticipate its general adoption). Science-July 17. 1800 w.

7120. The Use of the Hair Hygrometer. C. C. Trowbridge (Results of tests of Saussure's hygrometer in comparison with results of the wet and dry bulb determinations of humidity in air, show a nearer agreement than would be generally supposed). Science-July 17. 1100 w.

*7151. The Manufacture of White Lead. G. H. Robertson (The methods at present employed and the substitutes proposed). Elect'n-July 10. 2000 w.

*7152. Electrostatic Deflection of Cathode Rays. G. Jaumann (Showing that the electrostatic deflection of cathode rays is as characteristic of them as their magnetic deflection). Elect'n-July 10. 3500 w.

†7169. The Teak Trade of Siam (Report to the Colonial Office of Acting Vice-Consul Black of Bang Kok (Interesting description of the teak timber industry in its details from cutting to marketing). Ind & East Eng-June 27. 3200 w.

7178. Cotton. Henry G. Hester (Its relation to leading American seaports, past and present; the future of New Orleans as a cotton center; an original and interesting review of the cotton trades of the south as compared with the ante-bellum period). Mfrs Rec-July 17. 4000 w.

7179. How Cotton Is Bought, Sold, and Handled (General information by a member of a cotton firm). Mfrs' Rec-July 17. 1100 w.

7189. New Tesla Coil for X-Ray Work (Describes a coil known as the modified Tesla coil, placed on the market by the L. E. Knott Apparatus Co). Elec Rev-July 22. 700 w.

7217. The Effect of Inventions on the People's Life (Changes in the condition of the people resulting from inventions chiefly pertaining to the daily life, food, raiment, methods of working, books, newspapers, etc). Sci Am-July 25. 3500 w.

7221. Physics (Review of progress in physical sciences for the last half century). Sci Am-July 25. 1500 w.

7222. The Textile Industries of the United States Since 1846 (Review of American progress in the textile arts, with statistics). Sci Am-July 25. 2000 w.

7224. Chemistry (Rapid review of fifty years of progress). Sci Am-July 25. 1500 w.

7225. The Phonograph (An illustrated historical sketch). Sci Am-July 25. 1400 w.

7233. The Progress of Invention During the Past Fifty Years. Prize essay by "Beta" (Edward W. Byrn) (A diagram showing ratio of increase of U. S. patents for each five years, and another, showing yearly increase or decrease, and the relation of increase or decrease with critical periods in the history of the country, are interesting features of this able essay). Sci Am-July 25. 2200 w.

7234. Distinguished Inventors (Biographical sketches with portraits). Sci Am-July 25. 2800 w.

7236. Development of the Astronomical Telescope in Fifty Years (Historical, principally dealing with what American genius has accomplished toward perfecting these instruments.) Sci Am-July 25. 2400 w.

*7247. The Surviving Hypothesis Concerning the X-Rays. Dr. Oliver Lodge (The present aspect in the light of recent experimental progress. Exposition of the meaning of a prediction of Helmholtz, dating back to the early part of 1893). Elect'n-July 17. 2800 w.

*7248. Some Experiments with Röntgen Rays. John Burke (An account of some experiments the writer has been carrying out at Owens College). Elect'n-July 17. 1800 w.

†7262. Colombia: Region of the Magdalena; Trade of Barranquilla (The river system

of the country and facilities for the establishment of ports, with reference to present and future commercial requirements are discussed). Cons Repts–July. 4200 w.

†7268. The Sugar Industry of Formosa (Described from personal observation, by James W. Davidson. Copied from *Japan Daily Mail*). Cons Repts–July. 4300 w.

†7269. Cider Making in France (Description in detail from the selection of the apples, to the final bottling of the rectified cider). Cons Repts –July. 3800 w.

7270. The Temperature of Certain Flames. W. Noll Hartley (Description of attempts to ascertain temperature of flames). Am Gas Lgt Jour–July 27. 1600 w.

7271. The Relative Humidity of Southern New England and Other Localities. Report of Alfred J. Henry, Chief of Div. of Weather Bureau, U. S. Dept. of Agriculture (Results in tabulated form of extensive observations in various localities, with explanatory remarks upon the methods and their accuracy, and comparisons of humidity of different regions. Also diagrams showing curves of relative humidity, and statement of the relation of atmospheric humidity to kinds and quantities of useful crops). Bos Jour of Com–July 25. 5300 w.

*7293. Technical Education in Japan (Survey of progress with references to and brief memoranda of facilities afforded by technical schools already established). Engng–July 17. 2200 w.

7308. An Improved Focus Tube. Joseph F. Smith (Illustrated description of a tube that has given excellent results, with sciagraph of hand, showing shot). W Elec–July 25. 500 w.

†7329. Laboratory Note in the Heat Conductivity, Expansion and Fusibility of Fire-Brick. J. D. Pennock (The samples examined were Grecian magnesite, American magnesite, silica brick and coke oven tiling made in Belgium and used in retort coke ovens). Trans Am Inst of Min Engs–July. 700 w.

7367. A Possible Solution of the Problem of Weights and Measures. Sidney A. Reeve (An argument in favor of the duodecimal system and against the decimal system of weights and measures). Eng News–July 30. 800 w.

7373. Color Testing. Charles H. Williams (Read before the Boston Soc. for Medical Improvement. Experience with different methods examining a large number of men on the Burlington system of railroads. Description of a modification of Thomson's stick, employed for testing color vision, with other interesting and instructive particulars). R R Gaz–July 31. 3800 w.

†7395. Science at the University of Pennsylvania. Lewis R. Harley (Historical and general description of this institution, with illustrations, exterior and interior views, and more detailed description of departments in which chief contributions to science have been made). Pop Sci M–Aug. 7000 w.

†7396. Early Years of the American Association. William Henry Hale (This brief early history of the association is illustrated by portraits of eminent men who have presided over its councils). Pop Sci M–Aug. 1800 w.

†7397 The Scallop. Fred Mather (Illustrated description of this mollusk, its habitat, and the scallop fishery, methods of taking, and the preparing for market). Pop Sci M–Aug. 2700 w.

†7403. Forest Fires in New Jersey. John Gifford (Causes, the removal of which is imperative, and the effects of these fires upon timber, soil, seeds and game. Methods of fighting these fires when once started). Jour Fr Inst–Aug. 3000 w.

*7433. The Geological Formations Traversed by the Principal Rivers of England. Joseph A. Dickinson (From a paper read before the Manchester Geological Soc. on River Valleys. The rivers are geographically classified in six divisions, and examined). Col Guard–July 24. 3800 w.

*7438. Traction Engines and Roads (The topics of weight of traction engines as related to the sustaining power of road surfaces, legal restrictions and licenses, are considered from the English standpoint). Arch, Lond–July 24. 2000 w.

7442. The Diseases of Occupations. John S. Billings (Lecture before the Pratt Inst. The special diseases and accidents whose prevalency is increased by the various industries of civilization, or which are peculiar to particular industrial occupations are stated, with interesting facts connected therewith). Prog of Wld–Aug. 3500 w.

7452. The Burma Teak Forests. Dietrich Brandis, with editorial (The history of the management of these forests, given with some detail). Gar & For–Aug. 5. Serial. 1st part. 2600 w.

*7526. The Röntgen Rays. J. J. Thomson (The Rede lecture, given at the University of Cambridge, Eng. Brief reference to the discovery, with discussion of the rays and the effects they produce, etc). Nature–July 30. 6000 w.

7534. The Action of Illuminating Gas on Rubber Tubing. H. Grosheintz, in the Bulletin of the Industrial Society of Mulhouse (An account of experiments carried out by the author). Am Gas Lght Jour–Aug. 10. 900 w.

†7535. History of the Rubber Industry in New Brunswick, New Jersey. T. Robinson Warren (Historical account of this industry and the benefit it has proved to the town). Ind Rub Wld–Aug. 10. 2500 w.

†7536. The Management of India-Rubber Plasters. H. W. Medberry, in *The Western Druggist* (From an address delivered before the students of the Chicago College of Pharmacy. Gives brief history of plasters and describes the rubber plasters and their manufacture). Ind Rub Wld–Aug. 10. 1500 w.

†7537. Rubber Notes of Interest from Canada (Interesting information connected with trade in india rubber). Ind Rub Wld–Aug. 10. 2000 w.

†7538. The India-Rubber Industry in Europe (Interesting notes from various sources). Ind Rub Wld–Aug. 10. 1600 w.

COMMENT & CRITICISM

The Price of Gold.

IN the May number of this magazine there appeared an article on "The Present Value and Purchasing Power of Gold." This contained some statements which deserve a word of criticism. In these latter days of loose thinking and still more loose talking, we cannot be too exact in our statements. The first sentence of the paper is, indeed, a fact. "The value of gold is fixed in the long run by the cost of production." No one can successfully dispute this axiom. As the author goes on to say, price will not remain permanently below the cost of production, because men will refuse to produce that article for such a price. On the other hand, if large profits are being made, others will go into the business of producing, and these may be willing to sell at a lower price.

But the errors appear later in the article, when the statement is made that certain conditions have maintained gold abnormally above its value as determined by its cost of production; and further along the inviting prospect is presented that, because of these enormous profits, gold mining should be one of the most alluring industries of the times. While there is no doubt that gold mining is one of the most alluring industries of the times, the inferences to be deduced from these considerations is denied,—namely, that large fortunes await those who enter the field of gold mining.

In the first place, all admit that gold has value. Value has been well defined as "the power which an article confers upon its possessor, irrespective of legal authority or personal sentiments, of commanding, in exchange for itself, the labor or the products of the labor of others." This value is dependent on two conditions,—the want men have for the article and its difficulty of attainment; in other words, supply and demand. In order that anything shall be valuable, it must possess utility. One does not labor for that which he does not want. Is it true, however, that utility alone governs value? Not at all. Some of the most useful things in the world ordinarily possess but little value. Light, water, the air we breathe, are all highly useful,—in fact, absolutely essential to our life and health,—yet they are free for all, without money and without price.

The other condition of value, then, is difficulty of attainment. These two conditions of value gold possesses in an eminent degree. All men want it both for its use in the arts and for its purchasing power as money. It is also more or less difficult to procure gold in its native condition or from its refractory ores. Therefore a small quantity represents a considerable value. These conditions being as they are, we see that gold obeys the same laws that govern all other products,—namely, those of demand and supply. There may be a large demand for an article, but it does not necessarily follow that it will command a high price, as the supply may be correspondingly large. But with gold the supply and demand seem fairly to keep pace with each other. Its difficulty of attainment is practically constant, and, while there are new supplies being discovered, yet the demand for the product is continually increasing.

We now come to the main fact which was overlooked in the above quoted article,—namely, production at the greatest disadvantage. Although all gold producers may sell their product at practically the same price, it does not follow that they all make the same amount of profit. In fact, it is easily seen that the chances are that no two producers are making the same proportionate amount of profit.

This is what is meant by production at

the greatest disadvantage. As long as there is a demand for gold, men will go into the business of producing it. But some will have refractory ores to work. Others will have high wages to pay. Others may have high transportation charges against them. Thus they are not all on an equal footing. Some will be turning out gold much more cheaply than others. But do those sell their gold at a lower price than these? Not at all. Those who are producing most cheaply can be thankful for their good fortune and pocket the increased profits. But what does govern value? "The normal value of any kind of goods is determined by the cost of production of that last considerable portion of the necessary supply which is produced at the greatest disadvantage." Here, then, we have the key to the situation. Some men are in the business of producing gold who are just able to sell their product for what it cost to get it out, showing no profit. Their quota of gold is the last considerable portion of the necessary supply, but it is produced at the greatest disadvantage, and therefore fixes the price. All those who are above this plane make more or less of a profit, while those who are below it drop out, as they can not afford to produce long at a loss.

Thus it is seen why the present price of gold may not be considered abnormal. There are just as many grades of employer in the business of gold mining as any other; and business ability, cost of labor, and difficulty of attainment of product count for just as much as in any other occupation. While, therefore, it is undoubtedly true that some gold miners will make large profits, others will be found who are just able to make both ends meet, and who find that at the end of the year they are no better off than they were at the beginning. These men are necessary to the business, as without them the supply would not equal the demand and the price would go up. Others, however, would then go into the business, who would bring about the conditions as indicated herein, so that these considerations must be held to govern, and there will always be some who are producing at the greatest disadvantage. The point is, then, that some men will find gold mining, just as any other occupation, a losing business, and others will be engaged in it who are able to show a profit.

WM. ELMER, JR.

Trenton, N. J., August, 1896.

Quackery in Education.

THE article in your May number, on "Quackery in Engineering Education," by Mr. Edgar Kidwell, is not only timely, but extremely refreshing.

You were fortunate in obtaining for your contributor one who can use a pen and has sound ideas upon practical education; as he is not an engineer in private practice, it cannot be said that he writes in this vein because his own practice is being cut into by the professional professor.

Our schools, colleges, and universities are overrun with professors, men whose business it should be to teach certain branches of learning; whose best energies, mental and physical, should be directed toward keeping abreast of the times in the study and solution of the problem of practical education and to applying the same by precept and example. Men who deliver semi-occasional lectures, chiefly culled from the ancient masters, should not have the title of professor; let them be called what they more or less properly are, "lecturers." Even if we grant that the once time-honored title of professor has fallen into unworthy hands, it is nevertheless true that there are many instructors in our primary schools far more deserving of it, because they are truly successful teachers, than many of the self- or catalogue-styled professors.

Mr. Kidwell's remarks relative to the fitness of trustees of technical schools are but too true. How often we see the effect of the preponderating influence of the business man or moralist! And what is or should be a successful technical school? That one whose professors write the most articles in the *North American Review*, or publish the text-books with the greatest number of pages; that one which does the most advertising, or whose foot-ball team wins the championship, or whose register contains the longest list of names? Or is it possibly that small, unheard-of school whose instructors have far more stubborn material to handle than the larger and more advertised schools (which from very force of numbers must fall upon specially gifted men whose later doings will add to the renown of their Alma Mater), and which yet makes of this obstinate material well-grounded, practical, thinking men,—men who will use all their senses, if necessary, to arrive at a result? Let technical schools advertise, if they must; very few are beyond the necessity; but let it not be by prostituting professorship.

There are few, if any, who will gainsay the fact that there is something decidedly wrong in the practice of college professors who devote the major part of their energies and time to private pursuits and interests. And plainly the blame for such practice rests both with the trustees and the professor. The professor maintains his association with the college, and, for a fixed consideration, does but little more than loan the use of his name and reputation to the institution. As a practical educator, he may amount to naught. With the trustees it is the question whether the institution requires advertising more than a reputation for sound training. With the professor it should be largely a question of professional ethics. Can the professor reconcile his conscience with the fact that he is deceiving both students and their parents into accepting the catalogue-conceived notion that he is actually head of his department? True, a private practice of $20,000 or $30,000 a year will act as a wonderful panacea for mangled consciences, But is not the professional quack, in usurping the place of a better fitted or more conscientious man, doing the students under him the greatest wrong and injustice, in not giving them the direct benefit of his best thought and energy? And it is not always the case that the professor has brought his reputation to the college; it has often been made while there, at the expense of the institution and its students.

The writer is not one who would make a slave of the professor. Let his institution give him all the time and money it can spare for independent study and research; but the practical results of such study and research are by right and title the direct heritage of the students.

Then, if he wish (as we hope), let him give his ideas and results to the world and reap what personal profit arises therefrom. It is simply that the primal end in view should be the direct benefit of the student, and not that of self.

One cannot but think that Mr. Kidwell is slightly illogical in his remarks about the "$15,000 experimental steam engine." The E. P. Allis Co. would hardly look for ideas to the crude and hastily-formed notions of college students, whose experience is confined to testing or taking down and setting up some engine. Experience, familiarity with the strength or weakness of design and operation in countless other machines, is the true ground-work for such results. And *is* experiment or practice with a $700 engine as instructive as with a $15,000 engine? With equal reason one could be satisfied with teaching the student of civil engineering the uses of the surveyor's compass, letting him get from text-books, lectures, or later life his ideas of the modern engineer's or mining transit, with its solar attachments, micrometers, stadia wires, etc.

There are many of your readers who will be glad to hear the changes rung on the subject Mr. Kidwell has introduced.

M. P. PARET.

Lake Charles, La., August, 1896.

3426—A

A Correction.

IN Prof. A. Humboldt-Sexton's article on "The Important Feature of Producer-Gas," in the August number of THE ENGINEERING MAGAZINE, on page 914, "the yield of (Mond) gas from a common slack containing eleven per cent. of ash" should be stated to be one hundred and sixty thousand cubic feet per ton, instead of "one hundred thousand," as it there appears.

The error arose from a mistake in reading manuscript figures, and unfortunately the author's corrected proof was not received until after the publication of the magazine.